SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY 1922.

GENERAL PHYSICS.

235. *Measurement of the Volume of the Mercury Meniscus.* **J. T. Palacios.** (Anal. Fis. Quim. 7. pp. 275–295, Nov., 1919.)—The meniscus is produced at the top of a steel cylinder into which short tubes fit, ranging from 0·5103 to 1·2 cm. in radius; the height of the meniscus, up to 2·1 mm., is determined by a micrometer screw. The volume of the meniscus and the surface tension are calculated by graphical integration; the volume is a function of the radius and height, the surface tension changes with time. The paper is mainly tabular. The very large number of figures run closely parallel to those of Scheel and Heuse [Abs. 1563 (1910)], but there is a constant difference which would vanish if the radii of the tubes of the latter were all wrong by 0·04 mm. **H. B.**

236. *Intercomparison of Standard Yard Measures.* **J. M. Baldwin.** (Roy. Soc. Victoria, Proc. 34. 1. pp. 49–54, 1921.)—In the year 1845, forty similar bronze bars were cast in London. All were made into replicas of the Imperial yard by the insertion of gold plugs, properly lined, in the usual way. These were compared after manufacture; certificates were issued as to their lengths; and they were distributed to the colonies. During the war it was not feasible to send the national standards across seas, so the authorities in Melbourne, wishing to establish anew their yard, borrowed the standards from New Zealand (No. 18) and Tasmania (No. 37) and intercompared these with their own standard (No. 40). This comparison was done in June–Nov. 1918, in air at temperatures 48°–61° F. The standard No. 37 was found to be injured and thus only Nos. 18 and 40 remained. These were found to differ by $-0\cdot00016$ in., whereas according to the original certificates the differences had been $-0\cdot00009$, so that the relative change is $0\cdot00007$. Assuming that No. 18 has diminished by half and No. 40 has gained by half we have change in No. $18 = -0\cdot00003$; change in No. $40 = +0\cdot00004$. **P. E. S.**

237. *Diffusion of Air through Water.* **C. Barus.** (Nat. Acad. Sci. Proc. 7. pp. 133–134, May, 1921.)—Glass U-tubes were sealed at both ends nine years ago. Each arm contained water with air above, one arm having more water than the other. These apparatus have been in a dark vault at nearly constant temperature. During the last seven years the water-levels have been observed with the cathetometer, and the values calculated of the coefficient of diffusion of air through the water. The values found are in two cases $1{\cdot}10 \times 10^{-12}$ and $1{\cdot}87 \times 10^{-12}$.

P. E. S.

238. *Effect of Systematic Errors in Most Probable Values.* **R. Fürth.** (Phys. Zeits. 22. pp. 625–628, Nov. 1 and 15, 1921.)—There are two classes of problems in the determination of the most probable value of a physical constant from a finite number of observations subject to error. In the first the assumption is made that the probable error can be reduced to any assignable value by sufficiently increasing the number of observations. The author states that it cannot be universally assumed that the value which, according to a given method of computation, is affected by the least probable error, is necessarily the most probable value. In the second class each value Δ of a constant D is affected with a certain probability $\phi(\Delta)$. It does not follow that the value of Δ for which $\phi(\Delta)$ is a maximum is necessarily the most probable value of D. As an example the author takes the determination of the Brownian movements, and he demonstrates the truth of his conclusions in this case.

J. W. T. W.

239. *Dimensional Considerations based on the Hypothesis of Equal Distribution.* **L. Schiller.** (Zeits. f. Physik, 5, 2 and 3. pp. 159–162, 1921.)—Although in technical mechanics and, especially, hydrodynamics, valuable applications of dimensional considerations have been made for some time past, it is only recently that such applications have been made in the realm of pure physics. Reference is made to Runge's work [Abs. 965 (1916)] and also that of Hopf and Einstein, the latter on the thermal conductivity of insulators. The present paper contains a number of examples to show how under definite limited assumptions a group of regularities based on the hypothesis of equal distribution may be derived by simple dimensional considerations. A special dimension is usually given to temperature which is not based on the three fundamental units M, L, T, without special assumptions, but here it is taken as the average energy of a degree of freedom of the atom, and, so defined, has the dimensions of energy and only differs from the usual degree unit by a constant factor. Atomic weight is usually considered a dimensionless number and in this form is inaccessible to dimensional considerations, but in the present paper the mass of an atom is taken as its atomic weight. The dimensions of specific heat are then found to be $\sigma = \mathrm{ML^2\,T^2/(T^2M\,.\,ML^2)} = 1/\mathrm{M}$, i.e., the reciprocal of a mass. Since the atomic weight has the dimensions of a mass, Dulong and Petit's law follows, namely: Specific heat × atomic wt. = const. In a similar manner, when the equal distribution hypothesis is assumed for electrons, the Wiedemann-Franz law is found by formation of a dimensionless expression from the thermal conductivity ω, electrical conductivity δ, and electronic charge e, namely: $\omega/\delta = \mathrm{const.}/e^2\,.\,\mathrm{T} = \mathrm{Const.\ T}$, where T is the temperature. A whole series of similar relations are shown, and a table of data for ten metals is included,

the latter having not hitherto been published. The author claims this method not only to be valuable for the discovery of new relationships, but also to afford support for the equal distribution hypothesis.
H. H. Ho.

240. *The Evaluation of Quantum Integrals.* **E. C. Kemble.** (Nat. Acad. Sci., Proc. 7. pp. 283–288, Oct., 1921.)—Gives a method of evaluating integrals of the type $J = 2\int_a^b \sqrt{f(q)}dq$ where a and b are roots of $f(q) = 0$. A method employed by F. Tank is shown to be faulty. W. G. B.

241. *Stress-Strain Curves for the "Flow" of Solids.* **H. Lorenz.** (Zeits. techn. Physik, 2. 10. pp. 271–278 and 12. pp. 344–351, 1921.)—Starting from the assumption that the particles (crystals) of a solid body experience a resistance to rotation frictional in its nature, and taking a simple law of distribution in order to average, equations of curves representing the relations between stress and the irreversible part of the strain are deduced. The curves obtained without averaging show definite elastic limits, and for this case the release curve is a parallel to the Hooke's law line. The curves obtained by averaging resemble those obtained experimentally for cast-iron and copper, and show a definite breaking stress. The angle which the ruptured surface makes with the direction of the stress is also found to depend upon the constants expressing the properties considered. Release curves now start parallel to the Hooke's law line, but curve, and ultimately, if the stress is reversed, merge tangentially into the stress–strain curve starting from the unstressed state. "Hysteresis" loops, the area of which represents work converted into heat, are obtained for successive reversals of stress. All the possible representative points on a stress–strain diagram are found to lie within a curvilinear quadrilateral. Further plausible assumptions result in explanations of "after-working" and "elastic fatigue." W. G. B.

242. *Effect of Plastic Deformation on Crystals of Ductile Metals.* **E. C. Bain** and **Z. Jeffries.** (Chem. and Met. Eng. 25. pp. 775–777, Oct. 26, 1921.)—The authors examined the Hull pattern produced by the X-ray spectrometer on very coarsely crystalline copper and aluminium. The specimens were then subjected to moderately severe and to very severe cold work and finally annealed, X-ray spectrograms being taken between each treatment. The cast material indicated few orientations, the moderately deformed material some new orientations, while the severely worked material gave a pattern characteristic of an extremely fine-grained material, such as is obtained from the finest powders. Annealing produced a great reduction in the number of orientations.
J. L. H.

243. *Critical Loads of Struts with Elastic Supports.* **H. Zimmermann.** (Preuss. Akad. Wiss. Berlin, Ber. 45. pp. 775–790, 1921.)—Extends previous work [Abs. 809, 980 (1907)] on the critical loads of struts fixed or supported at two or more points, to the case when one or more of these supports is capable of elastic deformation, and in the deformed state exerts a bending moment on the strut. For details the paper must be consulted. W. G. B.

244. *Large Reversible Deformations in Isotropic Solids (Extreme Limits of Stability.)* **M. Brillouin.** (Ann. de Physique, 15. pp. 362–412, May–June, 1921.)—Deals mathematically with large reversible strains in isotropic solids. A continuation of earlier work. [See Abs. 1360 (1920).] F. C. T.

245. *Application of Strain Functions to Problems in Loading of a Spherical Shell.* **T. Pöschl.** (Zeits. techn. Physik, 2. 8. pp. 216–222, 1921.)—Discusses the various cases of loading of a light rigid spherical shell. J. W. T. W.

246. *Explosion Test for Metals and Bearing Metals.* **M. Dreifuss.** (Zeits. Elektrochem. 27. pp. 320–324, July 1, 1921.)—In testing detonators the Metallwarenfabrik Oos places the cylindrical detonator on a plate of hard lead, resting on a steel ring, and measures the detonation crater. The author replaced the hard lead by tin, copper, zinc, various "stella" alloys of the metals Sn-Sb-Cu-Pb, a zinc bronze, phosphor bronze, and cast iron. The crater diameter decreased from 14 mm. to 7·6 mm., the depth from 8·2 to 1·9 mm., when the materials were arranged in the order stated, so that this explosion test would run fairly parallel to the Brinell hardness test. The plates were not shattered to such a degree as to make measurements impossible. H. B.

247. *Impact Endurance Tests of Rods of Varying Cross-Sections.* **W. Müller** and **H. Leber.** (Zeits. Vereines deutsch. Ing. 65. pp. 1087–1093, Oct. 13, 1921.)—The machine used is a Krupp machine. A tup of 4·18 kg. in weight drops through a height of 30 mm., delivering 86 blows per minute on the horizontal test-rod of 100 mm. span; after each blow the rod is turned axially through 360°, 180°, 90°, or 14·4°, so that the number of blows per rod revolution varies between 1 and 25. The rods are cylindrical, 15 mm. in diam., with a central round groove, 1 mm. in depth, reducing the rod thickness at that part to 13 mm.; this thickness was always the same, while the groove widths varied. The other rods have diameters of 13 and 17 mm. in the left and the right halves, the transition being of the form of a fillet or a conical taper. The tup strikes the groove or the fillet or cone. The materials were chrome-nickel steels with—A: 0·12 C, 4·93 Ni, 0·94 Cr; B: 0·40 C, 4·52 Ni, 1·00 Cr; D: 0·13 C, 3·57 Ni, 0·57 Cr; or a pure carbon steel C with 0·13 carbon; all were annealed. In the experiments the numbers of blows are determined which produce cracks (Z_R) and the blows producing fracture (Z_B). The first series were concerned with the influence of rotation through the various angles. The material suffers most when under alternating stress (at 180°), least when the tup always hits the same spot (360°), the other cases being intermediate; the number of blows between the formation of the first cracks and final fracture increases with the number of spots hit (1 to 25). In order to trace cracks, the respective ring zone was painted with aniline when only a few more blows were required to cause fracture. The groove depth was constant, 1 mm., as mentioned; when the groove width was raised from 2 to 7·7 mm., both the Z_R and Z_B increased, the Z_B nearly to five times its initial value, but their difference $Z_B - Z_R$ increased very little, whilst in the first series of tests this difference varied greatly. All the grooves, as well as the fillets and cones, were very carefully finished. In the tests of the fillet specimens (steel C used), the Z_R and Z_B rose steadily as the fillet radius increased from 0 to 4 mm.; the curves then turned horizontal, there being little further increase between radius 5 and 7 mm.; the $Z_B - Z_R$ was nearly constant; small shallow tool-marks proved of no consequence. With the conical tapers the length of the cone (0 to 4 mm.) scarcely affected the Z_B and Z_R; the strengths were found lower than in the previous series, but the material D was less strong. In some tests the specimen was turned down to remove the cracks formed by a certain number of blows; the material then appeared stronger, in spite of the reduced diameter. It would hence appear that surface irregularities and cracks should be removed, the shafts finished carefully, and fillets be used rather than cones when the cross-section changes. H. B.

248. *Oscillations of a Mechanical System with Finite Amplitude and their Quanta.* **M. Born** and **E. Brody.** (Zeits. f. Physik, 6. 2. pp. 140–152, 1921.)—Outlines a general method of solving the equations of oscillation of a mechanical system, when the terms of the third and higher orders in the potential energy must be considered. A transformation due to Poincaré reduces the equations to trigonometric form, and it is shown how they may be solved in (finite) trigonometric series by successive approximation. The solutions are actually worked out to the third approximation, and Schwarzschild's quantum conditions are applied. W. G. B.

249. *Hydraulic Régimes.* **C. Camichel.** (Comptes Rendus, 173. pp. 629–632, Oct. 17, 1921.)—Discusses results of experiments on stream-line and turbulent flow in tubes. Stream-line flow was obtained for velocities greater than accepted ideas would predict, with suitable conditions up-stream. The close interdependence of all portions of a hydraulic system is emphasised. The pressure gradient is found to vary as V^m for all states of flow, the index m depending upon the degree of turbulence; an index of the degree of turbulence derived from m is proposed. W. G. B.

250. *Necessity for the Existence of the Eddy Component in the Motion of Liquids, when there is an Energy Variation along the Trajectories of the Various Particles.* **D. Eydoux.** (Comptes Rendus, 173. pp. 701–703, Oct. 24, 1921.)—The subject is developed mathematically on the lines of the general equations of hydrodynamics applied to perfect liquids. A. B. C. L.

251. *Theory of Wind Resistance.* **L. Prandtl.** (Zeits. Vereines deutsch. Ing. 65. pp. 959–965, Sept. 10, 1921.)—A general account of previous theoretical work on air-resistance to moving bodies, with a description of recent work and its application to the design of aircraft. J. W. T. W.

252. *Modes of Motion of Water in Open Channels.* **A. Schoklitsch.** (Akad. Wiss. Wien, Ber. 129. 2A. Nos. 9 and 10. pp. 895–917, 1920.)—Records, with numerous photographs, the results of a study of the flow of water in open channels, with and without obstacles, by means of threads of coloured water. For small depths stream-line flow is obtained. For greater depths (and consequently greater velocities) the coloured threads remain straight at a distance from obstacles. The central streamline at the bottom of the channel now divides and passes quite clear of the obstacle, the cause being that the surface water dives near the obstacle, and spreads on the bottom of the channel. Vortices, with horizontal axes across the stream, are thus formed in the neighbourhood of the obstacle. For greater depths and velocities the coloured threads become tortuous, indicating turbulent flow. Evidence is given of various states of turbulence, with consequently more than one "critical velocity," and this explains the lack of concordance of the Reynolds' numbers associated with the critical velocity obtained by different observers. W. G. B.

253. *Theory of Gravitation in Two-Dimensional Space.* **K. Ogura.** (Comptes Rendus, 173. pp. 909–911, Nov. 14, 1921.)—In studying the orbit, assumed plane, of a planet, a space of two dimensions only need be considered, time being added as a third dimension. On this basis, it is shown that, under given conditions, the Schwarzschild-Eddington form can be deduced. The theory is developed mathematically. A. B. C. L.

254. *Report on the Axioms of the Einstein Space–Time Doctrine.* **H. Reichenbach.** (Phys. Zeits. 22. pp. 683–686; Disc., 686–687, Dec. 15, 1921.)—This paper is a compendium of the axioms of the Einstein relativity theory which fall into two classes—namely: light axioms and material axioms. The former are assertions only with respect to the physical properties of light exclusive of any relationship to material ideas. It has been shown that a complete space–time theory can be developed solely from these axioms. The material axioms signify the identity of the light-geometry so developed with the space–time theory of rigid measuring-rods and clocks. The possibility of such a separation must be regarded as the most important result of this investigation; i.e., without the validity of the material axioms, whose empirical confirmation cannot yet be realised, the theory of relativity is a valid and complete physical theory. The paper first contains the derivation of axioms for the special relativity theory. Section 1 deals with the axioms of time sequence; section 2, with the axioms of time comparison; section 3, with axioms of measurement; section 4, with the Lorentz-transformation; and section 5, with material axioms. The extension to the general theory of relativity is dealt with briefly at the close, a more detailed publication being promised for the near future. H. H. Ho.

255. *The Theory of Relativity.* **Q. Majorana.** (Accad. Sci. Torino, Atti. 60. 7. pp. 131–142, 1920–21.)—A general criticism of the relativist position. The importance of obtaining experimental information as to the fundamental postulate of the constancy of the velocity of light is emphasised. The author's own experiments [see Abs. 281 (1919)] with direct measurement (by means of a Michelson-Morley interferometer) of the velocity of light (Hg green line) subjected to Doppler changes of wave-length are referred to. Criticism of other methods follows. A. D.

256. *Physical Basis of the Extended Theory of Relativity.* **H. Weyl.** (Phys. Zeits. 22. pp. 473–480, Sept. 1, 1921.)—Section 1 deals with the extended relativity theory which expresses the metrical field in two fundamental forms, quadratic and linear, these being coupled together by invariance. The metric is a structure of the continuous field; the vectors and distances used having nothing to do with material measuring rods, since the metrical structure of the ether is manifestly of influence on the behaviour of material bodies. A discussion is given of the equality of mass relationships. In section 2 it is shown that the transference of a distance by congruent transformation ensues exactly as by reference to the radius of curvature. In section 3 the author corrects the impression that in his theory purely speculative questions have been mixed which can only be decided by experience. In sections 4 and 5 it is shown that by suitable assumptions, not only gravitational but also electromagnetic forces can originate from the metrical field. Section 7 deals with the strong red displacement shown by spiral nebulæ, and its evidence for a spacially closed universe whose masses are not uniformly distributed, as Einstein assumed, but separate islands swimming in empty space like the Milky Way system. Section 8 deals with integral invariants of the second and higher order. Section 9 discusses the group formulation of the space problem, and also the recent work of Eddington [Abs. 1001 (1921)]. The author regrets the absence of decisive experience for advancing rigidly the extended theory of relativity so as to include electro-magnetic phenomena. H. H. Ho.

257. *A Simple Probability Consideration for the General Theory of Relativity.* **E. I. Gumbel.** (Zeits. f. Physik, 5. 4. pp. 227–230, 1921.)—The author commences with the example of a sphere of radius R upon which n small circles are drawn of radius ρ analogous to Polya's so-called "Konfetti," i.e., no two of which possess a common point, and determines the probability of describing a great circle through the centre of any given one of the Konfetti which will not meet any of the others. The complete problem, which possesses certain similarities with the kinetic theory of highly compressed gases, is not considered, but the Konfetti are assumed not to be too densely distributed, and the simple case of only two Konfetti is first investigated. Section 2 then deals with the case of a sphere in four-dimensional space under the above limitations. The probability is found to be, $W = e^{-8\rho^2 k R \pi}$, where k represents the density of the Konfetti. This result permits an interesting deduction for the general theory of relativity, namely: If the universe be regarded as finite and spherical, R its radius, k the average density of the stars, and ρ the average radius of a star, then W is the probability that a light ray proceeding from one star shall circulate the entire universe without being intercepted by any other star. The magnitudes appearing in the formula are naturally inexact, but as an approximate solution if ρ be taken as the sun's radius and the light-year as the unit of length, then since the radius of the universe is about 10^{13} times the earth orbit's radius according to a calculation by de Sitter, $R = 10^8$ light-years. Concerning stellar density, Freundlich states that in the neighbourhood of the earth a cube of side equal to 8 light-years will contain 8 stars. The author concludes that under his assumptions, a ray of light can complete its passage round the universe and return to the starting point. The finite character of the universe thus appears capable of experimental demonstration. H. H. Ho.

258. *Gravitation Fields Independent of Mass in the General Theory of Relativity.* **E. Reichenbächer.** (Phys. Zeits. 22. pp. 634–636; Disc., 636, Nov. 1 and 15, 1921. Paper read before the Deutsch Physikertag, Jena, Sept., 1921.)—The general theory of relativity has put forward the challenge that the measures of space and time are dependent on the matter present in the universe and on its motion. All the masses of the universe determine the $g_{\mu\nu}$ field of the space–time continuum, and this is not the same when judged from one body as from another, since the motions of those masses producing the $g_{\mu\nu}$ field for both systems are very different. The problem now arises as to whether a contradiction exists between the assumption of a flowing gravitational field $g_{\mu\nu}$, and the present conception that the gravitational fields are bound up with the masses producing them similar to electromagnetic fields and electrically charged particles, and if this be the case, to render a deciding solution. The author discusses at the outset the idea of a world on the general relativity theory, which possesses a gravitational field independent of the producing masses. The best known example of such is the system of uniform rotation in the Minkowski world, as worked out in particular by Kottler, in which effects completely independent of mass exist such as the Corioli and centrifugal forces. This conception from the above standpoint cannot be dissociated from a gravitational effect, when the world must still remain pure Minkowski. Other examples of such mass independent systems are described.

The influence of such results on space and time measures is then discussed, an influence which is fundamental in the four-dimensional gravitational theory and conceived in two kinds of ways. From the standpoint taken by the author the two kinds of effects, namely, inertia and Newtonian gravitation, are clearly different, and the attitude of the general theory of relativity towards this difference is criticised.

In the discussion which followed the paper, **Frank** pointed out that fields independent of mass occur also on the Newtonian theory. The homogeneous gravitational field cannot be explained by finite masses. The **Author,** in reply, stated that the homogeneous gravitational field is the only one which is in accord with an inertia field, i.e. with uniform accelerated translation. The actual gravitational fields to hand are entirely of another kind. H. H. Ho.

259. *Escapements and Quanta.* **J. Larmor.** (Phil. Mag. 42. pp. 592-594, Oct., 1921.)—An electron fired into an atom appears to be sometimes retained and its energy emitted again in Röntgen rays, mainly of periods so sharp as to involve a train of many thousand waves regular in amplitude and phase. Yet an unsustained electric vibrating system would be quenched in a few vibrations. Take the analogy of a clock with compound pendular system with a group of sharp periods in its complex oscillation. The free vibration would die away rapidly; but, if connected through an escapement, with driving spring or weight, the vibration will continue for long, just the small *quantum* of energy required for maintenance undisturbed being picked up from the drive at each engagement of the escapement. The outer electron-system of the Rutherford atom, which emits the lines of a spectral series, and determines chemical quality, may be taken to correspond with the pendular system, being maintained in undisturbed vibration through the energy of the core (which, perhaps sheltered, is anyhow too stiff to appear sensibly in physical activities) imparted gently through an escapement action. The vibration lasts for many periods and is renewed whenever the core is wound up by its entrapping a particle with its translatory energy. A connection between the energy feed and the free period ($\epsilon = \nu h$) is, however, wanting. Perhaps also the clock may be reversible, so that absorption of incident radiation of suitable period may wind up the driver—pointing ultimately to instability and ejection of a particle from the core in the manner recognised. Such quantised maintenance is far from the recognised smooth vibrator of optical theory, which is ineffective as regards sharp selective spectra, but is parallelled by the case of a blown organ pipe or a bowed string. And an escapement may be imagined as modified into a smooth continuous mechanism of constraint. Moreover, in the usual vibrator of optical theory, equipartition of the energy between the periods, so far as it may exist, can be assisted only during molecular encounters, a much coarser intervention of fortuitous discontinuous processes intervenes than those of a regular automatic escapement system. But consider, alternatively, the Rutherford atom as an outer physical system with constant periods of free vibration, linked dynamically—but only so slightly as not to displace the periods—to a core of more complex elasticity or structure so as not to be restricted to its intrinsic periods, and of stiffness to form an energy receptacle of large capacity, replenishable from colliding ions or otherwise. The core may then gently feed out the energy so acquired to the linked physical-chemical system as the blast feeds energy to organ-pipe vibrations. On Helmholtz's exposition the vibrating air jet which blows the pipe, though alternating, need not be discontinuous. General dynamical explanation is thus suggested of a periodic system linked by slight continuous coupling with another system of perhaps simple type but not periodic, and of large energy capacity. It is also suggested that wherever discrete energy-quanta appear in physical investigation, they may well be packets separated by the atomic mechanism involved —just as period in natural radiation is said in a certain sense to be a creation of the resolving prism or grating—so avoiding the difficult assumption of discreteness in energy itself. The quanta of practical physics would of course be large multiples of these packets. It is implied in the second alternative representation that the outer (electric) system of periodic quality is of type sinking into a configuration free from further loss by radiation, whenever the feed of energy fails; indeed, no other type could subsist, and the author considers the possibility of such electric types in a further note (*ibid.*, p. 595. Paper read before the British Assoc., Sept., 1921). To the first order, neglecting atomic size relatively to wave-lengths, the condition of absence of radiation from undisturbed orbital systems of electrons is $\sum e\dot{v} = 0$, where $\dot{v}$ is the acceleration of the electron e. The additional conditions for validity to the second order are the vanishing of the nine expressions of the type $\sum e\ddot{x}v$ (including $\sum e\ddot{x}x$, etc.): the twelve conditions are parallel to those of astatic equilibrium. The additions involve the fixity of the magnetic moment of the atom in magnitude and direction, so that if this be permanent, any rotational motion changing the direction of the moment will be resisted by radiation. This may preclude the existence of a permanent moment, or it may have a bearing on equipartition troubles. Atoms, for instance, of permanent symmetry with regard to three planes, can readily be imagined for which the radiation is residual, of the third order, in fact is so small that it ranks with such residual effects as are masked by electrodynamic relativity. An atomic orbital structure could subsist only at or near one of this set of configurations that do not radiate: by intense shock it can perhaps be imagined as pushed over from one of them into another, with loss of energy that goes in part into the disturbing system, and in part into radiation. G. W. DE T.

260. *On the One-Dimensional Brownian Movement.* **E. Buchwald.** (Phys. Zeits. 22. pp. 497–501, Sept. 15, 1921).—In a recent communication by Smoluchowski [see Abs. 518 (1916)] on the exit probability of colloidal particles, an expression of fundamental importance has been derived, namely, the probability that a colloidal particle initially in a given region of a sol may no longer be there after a given time-interval has elapsed. A number of related expressions are also investigated theoretically and experimentally. In the present paper corresponding considerations for the one-dimensional case are examined. In section 1, the exit probability is calculated for a particle after t secs.; in section 2, the probability is derived for a particle both entering and leaving during the interval t. In the first case the particle has complete freedom of motion; in the second case limitations are imposed. From the standpoint of the diffusion theory the first problem leads to a solution of the one-dimensional diffusion equation, which is characterised by a momentary source-point in the immediate vicinity of the place of entry; the second problem is characterised by an infinite series of equi-distant instantaneous double source-points on the Z-axis. H. H. Ho.

261. *A Contribution to the Conception of Homopolar Atomic Union.* **W. Hückel.** (Zeits. Electrochem. 27. pp. 305–309, 1921.)—Kossel has carried out a number of investigations [see Abs. 641 (1916)] in order to obtain an explanation of the forces acting between the atoms within the molecule and in the space-lattice of crystals. A particularly sharp limiting case of the binding relationships was found for the large class of substances built up of electrons. The endeavour of the atoms in such a compound is to imitate in electronic configuration those noble gases which precede or follow them in the periodic system. In these heteropolar compounds this configuration is attained by very strong action of the electronic systems on the separate atoms; one atom gives to the other or takes from it so many electrons that in every so-formed charged ion the number of the electrons contained in the particular noble gas is attained. The consequence of this electrical charging of the atom is an electrostatic attraction obeying the Coulomb law, which conditions the union of the atoms in the molecule or in the lattice. A stable arrangement of ions so united is, however, only possible when, in addition to attractive forces those of repulsion are also to hand, which latter produce equilibrium with the former at a certain atomic distance. The essential knowledge of their nature for Kossel's considerations is still lacking, although their magnitudes may be calculated for certain compounds from physical constants. The repulsion forces decrease by a high power of the distance from the atomic nucleus, *e.g.*, Born has found the ninth power for the ionic lattice from a study of compressibility, thereby affording the picture of a rigid impenetrable atomic surface enclosing nucleus and electrons. In these heteropolar compounds every atom present as an ion contributes its own electronic system which is separated spacially from the other ions. Such a heteropolar conception of the uniting forces does not explain all the union relationships, and Kossel in consequence introduced the idea of homopolar union without making definite assertions as to its nature. The limiting case, again, is capable of simple interpretation. Kossel opined these binding forces as van der Waals cohesion forces. The electronic arrangement of such an atom or molecule suffers a deformation in the electric field of the other due to displacement of the average position of the electrons. This displacement follows in both atoms or molecules, in the sense that the dipoles arising attract each other. A stable atomic arrangement is then found as in the case of the heteropolar considerations above. In these purely homopolar compounds, every atom or molecule contributes its own electronic system whose configuration appears to be only slightly changed in the compound. Between the two extremes, namely, the scarcely altered electronic configuration of the binding atoms or molecules of the purely homopolar compounds, and the completely altered heteropolar compounds when the ionic state is assumed, arise transition stages to which a dynamic interpretation cannot be withheld, since the motion of the separate electrons must be treated in the possible orbits afforded by the quanta theory. Such an atomic arrangement has been sought after by Bohr and Debye for the hydrogen molecule, and for the chlorine molecule by Born and Landé, in which two electronic cubes of 8 electrons have an edge, i.e., two electrons, in common. In these models every atom has no longer a closed electronic configuration, but several electrons belong simultaneously to the atoms. In like manner the probability also arises that every electron can no longer be arranged with a definite atom as in the purely heteropolar and homopolar configurations.

The present paper contains an attempt at investigating the transition types from the heteropolar mode of union to the homopolar type. The following considerations really arose from a gap in the Kossel theory which was found when ammonia was compared with methyl substituted ammonias. According to Kossel ammonia is heteropolar, while a like assumption is untenable for methylamine—such a fundamental structural difference is not compatible with the profound similarity in chemical behaviour. Accordingly, the heteropolar structure is doubtful for ammonia, although so evident to Kossel. These transition types occur quite generally in hydrogen compounds in so far as the hydrogen in them has not assumed the helium configuration by acceptance of an electron, as in the case of LiH, i.e., a transition from the purely heteropolar to the positively homopolar compounds exists on account of the absence of the internal electronic frame for the hydrogen. The work of Kratzer on the ultra-red rotation spectra of halogen halides and of Reis on the comparison of their molecular volumes and ionic separation energies is referred to. The carbon compounds seldom exhibit a relatively pronounced polar character on account of the high symmetry of the carbon atom. The simple, double, and triple carbon bonds are conceived, on the ground of the number of the mutual C and + 1 valency electrons in the radicals methyl, methylene, and methane, as the mode of union of the fluorine, oxygen, and nitrogen atoms in their double molecules. In like manner the imine group corresponds in homopolar union to the oxygen atom, the amino and hydroxyl groups to the fluorine atom; BH_3, like oxygen, forms a double molecule. Carbon monoxide imitates in its electronic configuration the nitrogen molecule, since C + O possesses the same number of electrons as 2N. Isohydrogen cyanide is regarded as like CO. The great asymmetry of this molecule necessitates the dipole character, while the hydrogen nucleus inclines towards dissociation. The residue CN by accepting an electron from hydrogen acquires the number of electrons in the N_2 molecule and forms as ion a similar electronic configuration to N_2. Not every positively homopolar compound has its electronic arrangement of the F_2, O_2, and N_2 types, and for the present many are inexplicable. H. H. Ho.

262. *Constitution of Mixed Crystals and the Size of the Atom.* **L. Vegard.** (Zeits. f. Physik, 5. 1. pp. 17–26, 1921.)—Using the crystalline-powder method of Debye and Scherrer, in which a cylindrical film surrounds a pencil of pulverised crystals, the author has obtained photographic records of the X-ray spectra of a number of mixed crystals. The following systems have been examined:

$$\left.\begin{array}{c}\mathrm{KCl\text{–}KBr}\\ \mathrm{KCl\text{–}NH_4Cl}\end{array}\right\}\text{cubic}$$

$$\mathrm{K_2SO_4\text{–}(NH_4)_2SO_4}\ \text{rhombic.}$$

Comparison spectrographs were obtained for the simple crystals, KCl, KBr, NH_4Cl $(NH_4)_2SO_4$, and K_2SO_4.

The following table, included in the paper, shows the change of molecular volume produced by atom substitution in the various crystals:—

Crystal.	Number of Molecules in Elementary Cube.	a (Å. Units).	Δa (Å. Units).	v (Å.U.)^3.	Δv (Å.U.)^3.
KBr	4	6·5968	0·1545	71·77	4·93
KBrKCl	4	6·4423	0·1520	66·84	4·61
KCl	4	6·2903	0·0573	62·23	1·71
80 Mol. % KCl 20 ,, ,, NH_4Cl	4	6·3476	—	63·94	—
NH_4Cl (pure).....	1	3·881	—	58·46	—
NH_4Br (pure)	1	4·070	—	67·42	—
NH_4Cl (face-centred)	—	6·577	—	71·12	—

For the system KBr–KCl, the length of the side a of the elementary cube is found to follow the additive law with great accuracy: $a = (p - 100)/100 \,.\, A_{KBr} + p/100 \,.\, A_{KCl}$, where p is the molecular percentage of KCl in the mixed crystal. For the system KCl–NH_4Cl it has not been possible directly to verify the additive law.

The lattice structures of NH_4Cl and NH_4Br have been determined, and the size of the NH_4 group found to have a diameter $= 4·15$ Å.U. From the observations of the NH_4 halides and of $N(CH_3)_4I$ the diameters of hydrogen and carbon atoms have been deduced. Thus: $d_{carbon} = 1·53$ Å.U.; $d_{hydrogen} = 1·75$ Å.U. The theoretical significance of these results is discussed at the end of the paper. A. B. W.

263. *Constitution and Stability of Atomic Nuclei.* **W. D. Harkins.** (Phil. Mag. 42. pp. 305–339, Sept., 1921.)—The paper presents seven experimental correlations which are believed to exhibit the fundamental relations between the stability and composition of atom nuclei. Nuclear electrons seem to be associated in pairs and α-particles in groups of 10 or usually less, but sometimes more.

Three methods of classifying isotopes are proposed. While all of these were suggested in a somewhat different form in an earlier paper by the author, they were not outlined with sufficient definiteness to show their relation to nuclear stability. The three methods are: (1) classification into four groups according to the "oddness" or "evenness" of the number of electrons and protons in the nucleus; (2) classification into isotopic numbers which vary from − 1 for hydrogen and Rutherford's lower isotope of helium, to 0 for the most abundant atomic species, up to 54 for uranium; (3) classification according to series relationships.

The problem of nuclear stability is discussed in detail and the relations to the above systems of classification are pointed out. The discussions and graphical representations show a marked periodicity in the variation of "abundance," atomic stability, and a number of functions which express the composition of atom nuclei. A. B. W.

264. *Atomic Dimensions.* **M. Pierucci.** (N. Cimento, 22. pp. 189–198, Sept.–Oct., 1921.)—In March 1920 the author published in N. Cimento his conclusion that the atomic radii of all the elements at 0° C. were integral multiples of one and the same length. Data were, however, scanty. Revising now in the light of W. L. Bragg's data (Phil. Mag., Aug., 1920), he finds these not close enough to settle the question; but these data bring out that Bragg's data group round the diameters of the inert gases, and that his diameters for Ne, Ar, Kr, and Xe are in the ratios 4 : 6 : 7 : 8, where unity is 0·336 Å.U., as compared with the author's 0·342. The fusing-point of these four gases is given by the formula $T_{Abs.} = 79D - 81$; where D is the atomic diameter; and on this analogy helium with a probable fusing-point of 1° Abs. (not frozen at 2° Abs.) should have D approximately $3 \times 0{\cdot}342$ Å.U. A. D.

265. *Genesis of the Elements and Structure of the Atomic Nucleus.* **E. Kohlweiler.** (Phys. Zeits. 22. pp. 243–246, April 15, 1921.)—In two previous papers on the atomic nucleus and on isotopy [*ibid.*, p. 203 and p. 311, 1920], the author had shown that the elements may be arranged in two pairs of series, with even ordinal numbers and with odd numbers of components. In analogy to the disintegration series of uranium and of thorium (which form the ends of the even series) we may in both the pairs distinguish series of isotopes. The genesis was to occur in both the pairs by the incorporation, in the nucleus of the atom which predominates in the series, of He^{++} and of e^{-}. Only one of the theoretical isotope components might really exist, the others being absent owing to the instability of the nucleus. Thus the author predicted only one isotope for C, N, and O, as afterwards confirmed by Stern and Vollmer and by Aston. His theory also agreed with Rutherford's distinction of nuclei containing H^{+} and nuclei free of H^{+}. But he had not considered Rutherford's X_3^{++} as a fourth constituent leading to N14, and he was also unaware of Aston's Ne21 and Cl35 and Cl37 (he had assumed Cl34 and Cl36). He therefore modifies his table of the elements by inserting two short intermediate series. In his table the numbers of the four possible atomic constituents are indicated by figures within a bracket; thus 1Be11 (0324) signifies that there are no He++, $3X_3^{++}$, 2H+, and $4e^-$ in the nucleus of Be of mass 11. He also discusses the mass and energy relation, assuming that hydrogen has a mass of 1·00799 and e^- a mass of 0·00054, so that the H+ nucleus would weigh 1·00799 − 0·00059 = 1·00075; further that the loss of mass with formation of elements is equal to the energy liberated in that formation, which itself corresponds to the energy expended in disintegrating an atom; the latter he calculates from Rutherford's experiments. The agreement between calculated and experimental values is especially good for C, N, F, Na; S seems to have a weak component 34, which Aston's method would hardly be likely to disclose. H. B.

266. *Atomic Structure.* **N. Bohr.** (Nature, 108. pp. 208–209, Oct. 13, 1921.)—In connection with the problem of the constitution of the atom discussed in a previous paper [Abs. 1212 (1921)] the author now adds a few remarks about the manner in which the orbits of the electrons in the atom are characterised. According to this view of atomic constitution, the electrons in the atom are arranged in groups in such a way that the orbit of every electron within one and the same group is characterised by the same number of quanta. Since, however, for orbits characterised by more than one quantum there exist several types of orbits possessing the same total number of quanta, the electrons within each group do not in general play equivalent parts, but are divided into a number of sub-groups corresponding to different types of possible orbits.

The author then proceeds to elaborate this point of view and to apply the theory to the interpretation of the physical and chemical properties of the elements.

The paper is limited in scope to points of a general character, a complete detailed theory being in course of publication by the Danish Academy of Science. A. B. W.

267. *Arrangement of the Electrons in the Elements of Long Period.* **R. Ladenburg.** (Naturwiss. 8. pp. 5–11, Jan. 2, 1920. Chem. Zentrbl. i. pp. 315–316, 1920.)—Kossel's arrangement of the electrons is satisfactory up to scandium (at. wt. 44·4); for elements of higher atomic weight, another conception seems to be required. Kossel demands a definite predominant valency, whilst the elements between Ti and Zn (comprising the iron group and Cu), and those between Zr and Cd (comprising the Pd group and Ag) exhibit a series of variable valency stages, and their maximum valency, so far as it is distinct, does not increase from member to member, but remains constant. Some of these elements show peculiar properties, magnetism and coloured ions, properties dependent upon the detachment of the readily-separated outer electrons. The author suggests that the outermost zone of the elements mentioned (except Cu and Ag) contains 2 electrons, which would account for their metallic positively divalent character in their heteropolar compounds. The new electrons migrate into the interior of the outermost zone, forming an intermediate zone of greater freedom of motion, explaining the variable valency. In the case of Zn and Cd the number of electrons in the intermediate zone is already ten. When there are less than 10 electrons in that zone, the electrons are readily displaced by the energy of visible light; absorption of ultra-violet rays must be accomplished by the electrons of other, more complete, zones. The analogy between variable valency and the colour of the ions, both ascribed to loose attachment of the electrons in the intermediate zone, need not be complete. The connection between colour and ability to form compounds depends upon the amounts of energy which are required for the absorption of light, on the one hand, and the production of another degree of combination on the other hand; the quantities of energy are related in the same manner as the resonance potential and ionisation in the line spectra of metals. The suggestions are only to be regarded as preliminary; they do not account for the distinctive character of the electrons of magnetic elements. H. B.

268. *The Fine Structure of Isomorphous Substances.* **F. Rinne.** (Centrbl. Mineral. pp. 161–172, June 1 and 15, 1919.)—A discussion of modern views [cp. Abs. 481 (1919)] starting from Mitscherlich's statement of 1818 that "equal numbers of atoms, equally connected, give rise to equal crystal forms," which may be interpreted that crystal form depends upon the number and mode of combination of atoms, and not upon their nature. The edges of the elementary lattice cubes of Al, Cu, Ag, Au, Pb, have lengths $a = 4{\cdot}07$, $3{\cdot}61$, $4{\cdot}06$, $4{\cdot}07$, $4{\cdot}91 \times 10^{-8}$ cm.; the "spaces of interest" of an atom, $a^3/_4$, range from $11{\cdot}76$ to $25{\cdot}59 \times 10^{-24}$ cm.^{3} In the carbonates of Mg, Ca, Fe, Mn, Zn, Cd, the volume of interest of one carbonate group, *e.g.*, $MgCO_3$ varies between 45 and 59 (same units). In the face-centred cubes of NaCl, NaBr, etc., Br may replace Cl in mixed crystals. The valency, rather than the molecular volume, is of influence in isomorphism (vicariation) and in miscibility. Thus of the four metals mentioned only Ag and Au are perfectly miscible, not Au and Al, in spite of the equal a; in mixed crystals the miscibility changes much more with temperature than would be expected from the lattice dimensions. The author has examined by Laue's X-ray method mixtures of crystals and minerals like feldspar, mica, etc. He finds no fundamental differences, and pointing to the zeolites, in which Na easily replaces Ca, he regards isomorphous crystal mixtures as a link between chemical combination and physical mixture. H. B.

269. *Use of X-Ray Diffraction Patterns in the Complete Determination of the Crystal Structure of Quartz.* **C. Mauguin.** (Comptes Rendus, 173. pp. 719–721, Oct. 24, 1921.)—The author deals mathematically with the experimental observations of Bragg (X-rays and Crystal Structure, 1918, p. 160 *et seq.*), with reference to the reflection of X-rays from the various faces of quartz crystals. A. B. W.

270. *Langmuir's Theory of the Arrangement of Electrons in Atoms and Molecules.* **C. R. Bury.** (Am. Chem. Soc., J. 43. pp. 1602–1609, July, 1921.)—According to Langmuir's theory of the structure of the atom [Abs. 991 (1919)], each of the electron-containing cells may contain two electrons except the two cells in the inner shell which can contain only one; moreover, there can be no electrons in the outer shell until all the inner shells contain their maximum numbers of electrons. In place of this the author suggests the following postulate: The max. number of electrons in each shell or layer is proportional to the area of its surface; thus, successive layers can contain 2, 8, 18, and 32 electrons. Groups of 8 and 18 electrons in a layer are stable, even when that layer can contain a larger number of electrons. The max. number of electrons in the outer layer of an atom is 8; more than 8 electrons can exist in a shell only when there is an accumulation of electrons in an outer layer. During the change of an inner layer from a stable group of 8 to one of 18, or from 18 to 32, there occurs a transition series of elements which can have more than one structure. This postulate avoids the necessity of postulating cells in the structure of the atom, and leads to different structures for the elements of higher atomic weight than neon. The author claims that the application of Lewis and Langmuir's octet theory of valency to these structures affords a better explanation of the chemical properties of the higher elements than is obtainable from Langmuir's structures. T. H. P.

271. *Viscosities and Molecular Dimensions of Gaseous Ammonia, Phosphine, and Arsine.* **A. O. Rankine.** (Phil. Mag. 42. pp. 601–614, Nov., 1921.)—It was intended to include the study of stibine in this group, but no results were obtained, on account of the almost instantaneous decomposition of this gas even at ordinary temperatures. For the determinations, an apparatus similar to that employed in previous researches is used, with slight modification. Precautions taken to eliminate the effects of the three gases under investigation upon the surface tension phenomena of the mercury pellet used as an index are described. The numerical results obtained are shown in tabular form and the molecular dimensions are calculated on the basis of Chapman's formula. A. B. C. L.

272. *Viscosities and Molecular Dimensions of Methane, Sulphuretted Hydrogen, and Cyanogen.* **A. O. Rankine** and **C. J. Smith.** (Phil. Mag. 42. pp. 615–620, Nov., 1921.)—Describes viscosity determinations and calculations carried out on the lines of previous researches [see preceding Abs.]. In the case of cyanogen, the additional precision now available requires revision of the results already published for this gas [see Abs. 1682 (1921)]. A. B. C. L.

273. *Measurements of the Viscosity and Surface Tension of an Emulsion Colloid.* **H. Walter.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 7. pp. 709–720, 1920.)—Measurements have been made at various temperatures of the viscosities and surface tensions of aqueous gum arabic solutions of different concentrations. As regards the degree of dispersion, ultramicroscopic investigations show that the particles of the disperse phase exist in all cases as amicrons in the sol. The manner in which the viscosity is found to depend on the concentration and on the temperature, taken in conjunction with Einstein's formula, furnishes confirmation of the liquid nature of the disperse phase. For the relationships of the coefficient of viscosity to the concentration and to the temperature, empirical formulæ are developed. The results of the measurements of the surface tensions of the solutions and of the corresponding temperature coefficients, determined by Jäger's method, are worked out according to a formula established by Jäger (1896). The course followed by the capillarity-concentration curves indicates dependency of the surface tension on the degree of dispersion. T. H. P.

274. *Surface Tensions and Densities of Liquid Mercury, Cadmium, Zinc, Lead, Tin, and Bismuth.* **T. R. Hogness.** (Am. Chem. Soc., J. 43. pp. 1621–1628, July, 1921.)—The densities of these metals in the liquid state are expressed by the following equations, the max. difference between the observed values and those calculated from the equations being $0\cdot1\,\%$: zinc, $6\cdot59 - 0\cdot00097\ (t - 419)$; lead, $10\cdot71 - 0\cdot00139\ (t - 327)$; cadmium, $8\cdot02 - 0\cdot00110\ (t - 320)$; bismuth, $10\cdot07 - 0\cdot00125\ (t - 269)$; tin, $7\cdot01 - 0\cdot00074\ (t - 232)$. The surface tensions, measured by the Cantor method of drop pressure (1892), are represented in dynes per cm. by the expressions: mercury, $467 - 0\cdot043\ (t + 39) - 0\cdot000386\ (t + 39)^2$; bismuth, $378 - 0\cdot063\ (t - 269)$; cadmium, $630 - 0\cdot065\ (t - 320)$; lead, $444 - 0\cdot077\ (t - 327)$; tin, $531 - 0\cdot080\ (t - 232)$; zinc, $758 - 0\cdot090\ (t - 419)$. The values of the surface tension of mercury in dry air, in hydrogen, and *in vacuo* are virtually identical. The results obtained are compared with those given by other investigators. T. H. P.

275. *Dimensions of the Molecules of Fatty Oils, and some Phenomena of Molecular Solutions.* **P. Woog.** (Comptes Rendus, 173. pp. 387–390, Aug. 16, 1921.)—It has been shown previously (*ibid.*, pp. 303–306) that the greasiness of fatty substances depends to some extent on the tendency of the molecules to coalesce (*coincement*), a tendency which should become more pronounced as the molecules increase in dimensions. It was found that the molecular volumes for a number of fatty oils are distinctly higher than those of mineral oils of corresponding viscosity, and that, for mineral oils, the greasiness runs closely parallel to the molecular volume; the dictum that, for equal viscosities, the most greasy oil is that of lowest density, is thus explained, since in a homologous series the viscosity increases with the molecular volume.

Measurement of films of various fatty oils extended on the surface of water in a layer one molecule in thickness shows that, except in the case of castor oil, the molecules of oils appear to exhibit only slight asymmetry. Similar measurements made on the principal constituents of the oils give numbers differing little from those published by Langmuir in support of his theory of surface tension [Abs. 1230 (1917)].

If benzene solutions of a solid saturated fat and a liquid unsaturated fat are poured successively on to water, the surface covered by the products is equivalent to the sum of the areas of the molecules considered separately; these molecules are, indeed, orientated freely on the water and exert no mutual influence. When, however, benzene solution contains both the saturated and the unsaturated fat, the total area covered is no longer equal to the sum of the two separate areas. This phenomenon is attributed to an influence of the unsaturated molecules on the saturated, solid molecules, the two types of molecules forming groupings owing to the reciprocal affinity of their carboxyls. T. H. P.

276. *Superficial Extension of Soluble or Volatile Compounds.* **A. Marcelin.** (Comptes Rendus, 173. pp. 79–82, July 11, 1921.)—The property of spreading spontaneously on the surface of water in a layer apparently unimolecular in thickness, long known with oleic acid and various fatty substances, appears to be fairly general and has been already studied in the case of camphor (Ann. de Physique, 1913). The investigation has now been extended to a number of other compounds, some of which, like resorcinol, are too readily soluble in water to allow of quantitative study; with others, such as menthol and isobutylcamphol, the mean thickness of the layer formed agrees satisfactorily with the molecular dimensions. The "pressure of superficial saturation" has been measured in dynes/cm. for camphor and for a number of substances which behave similarly to it. T. H. P.

277. *Notes on the Angle of Contact.* **C. H. Bosanquet** and **H. Hartley.** (Phil. Mag. 42. pp. 456–462, Sept., 1921.)—In spite of the importance of the angle of contact both in the theory of surface tension and in its measurement, our knowledge of it is both scanty and unreliable; *e.g.*, it is still uncertain whether all liquids which wet glass have a zero angle of contact or not. Magie's work is referred to, in which a small finite, acute angle of contact was found for acetic acid, turpentine, petroleum, and ether, and the existence of such small angles has been suggested as an explanation of the differences found for the surface tensions of liquids by various methods (*e.g.*, capillary rise, drop weight, and Jaeger's method). The experiments now described consisted in: (1) A comparison of the values for the angle of contact between water and solid paraffin, determined directly and indirectly by measuring the capillary depression of water in a paraffin tube. It was found that the angle of contact between water and solid paraffin, at 14° C. is 106° 28′ by direct measurement, and 106° 57′ indirectly. (2) A determination of the angle of contact with glass of the liquids stated by Magie to give a finite angle of contact. It was even found that the tilting-plate method was unsuitable for the measurement of small angles of contact, and this was abandoned in favour of a special device for detecting such angles. In all cases investigated a zero angle was found with liquids that wet glass. (3) A search for a solid which has a finite acute angle of contact with water. Salol, dinitrobenzene, azobenzene, and triphenylmethane were investigated by fusing small quantities on microscopic slides, allowing them to solidify, and examining the curvature of the surface of water in contact with these films. Azobenzene was found to give a finite acute angle of contact with water, its mean value by three methods being 77° at about 15° C. Ample experimental details are included, and Abs. 1686 (1921) should be consulted. H. H. Ho.

278. *Effect of Electrification on the Surface Tension of a Liquid.* **F. Michaud.** (Comptes Rendus, 173. pp. 972–974, Nov. 21, 1921.)—The effect of electrification on the surface tension of a liquid has been studied by Herwig, C. M. Smith, Nichols and Clark, and S. J. Barnett. They have all concluded that electrification diminishes the surface tension, although Barnett, who worked with ripples, was of opinion that his results might also be explained by electrostatic repulsion. The author shows by thermodynamic reasoning that the surface tension of a liquid should be independent of the state of electrification of the surface. He describes an experiment in which electrostatic repulsion effects are eliminated and which confirms his theoretical deduction. A long thin plate of Al hangs vertically from one end of the beam of a balance and dips into the liquid to be investigated. This plate passes through a slit in a horizontal metal disc fixed 1 cm. below the surface of the liquid. The capacity of this arrangement remains constant for a small vertical displacement of the Al strip. The p.d. between the plate and disc was of the order 10,000 volts. The balance remained undisturbed on charging, although the sensitiveness was such that a change of 1 part in 300 in the surface-tension pull on the vertical plate would have been observed. The liquids used were ordinary and distilled water, sodium carbonate solution, hydrochloric acid, alcohol, and soap solution. L. L.

279. *Molecular Forces and their Electrical Significance.* **P. Debye.** (Phys. Zeits. 22. pp. 302–308, May 15, 1921.)—A theoretical paper not permitting of a concise abstract. A. B. W.

280. *Molecular Structure of Thin Films of Palmitic Acid on Water.* I. **N. K. Adam.** (Roy. Soc., Proc. 99. pp. 336–351, July 1, 1921.)—The paper describes experiments undertaken to confirm the views put forward by Langmuir regarding the arrangement of the molecules of various substances spread upon the surface of water. A modification of the technique for examining the properties of thin films of substances on water is described, special attention being given to the avoidance of leaks past the confining barriers, and to correcting for the residual contamination on the water which cannot be wholly avoided. Experiments on palmitic acid are described, and, in general, confirm Langmuir's results. The compressibility curves are straight lines, except for possible doubtful deviation at very low compressions. The film changes abruptly in properties at a H-ion concentration about 10^{-5} *N*. The change is confined to films under compression less than about 16 dynes/cm. The area occupied by each molecule becomes about 20 % greater than on neutral solutions. Langmuir's view that the films consist of a single layer of molecules, oriented with their — COOH groups towards the water, is confirmed and extended. On neutral solutions the molecules rise in the water so that the — COOH groups are in contact with each other. There is independent evidence of an increased attraction of water for — COOH groups as alkalinity is increased. The formation of the "ionic micelle" of soap, as the film dissolves in more alkaline liquids, is a simple consequence of the increased attraction of the — COOH groups and the attraction of the chains for each other. At ordinary temperatures, hysteresis in unimolecular films of palmitic acid is absent, or extremely small in amount. Palmitic acid is completely insoluble in slightly acidified water, the films preserving their area and properties unchanged for hours. Compression beyond a certain point causes collapse of the film, the ejected molecules forming aggregates visible to the naked eye. The remainder of the film appears to be unchanged in properties. Different films—even different parts of the same film—vary considerably in their resistance to collapse. A. B. C. L.

281. *Surface Tension of Monomolecular Layers.* **A. Marcelin.** (Comptes Rendus, 173. pp. 38–41, July 4, 1921.)—Rayleigh has shown [see Abs. 13 (1900)] that certain oily liquids extend themselves on the surface of water in layers of thickness of the order of the molecular diameter, and it was considered that the layer at max. extension consisted of molecules in contact, the surface tension decreasing with the diminution of extension and varying very slowly from the point where the layer formed a double thickness of molecules. In 1913 the author showed a discontinuity in the case of oleic acid comparable with the liquefaction of a vapour. It was shown that any quantity of the body placed on the surface of water already covered with a thickness sensibly double that corresponding to max. extension no longer suffers spontaneous extension and remains in the state of globules. Such a layer is considered *saturated*. The difference between the surface tensions of pure water and water covered by a *saturated* layer is called the *saturation pressure*. The apparatus employed for measuring the surface tensions is described and the numerical results obtained with oleic acid, isobutyl camphol, and gamboge are set forth and discussed. A. B. C. L.

282. *Dynamics of Capillary Flow ; Movement of Moisture in Soil.* **W. Gardner.** (Phys. Rev. 18. pp. 206–209, Sept., 1921.)—Attention is called to experimental data which show that there usually exist in the soil appreciable moisture gradients which indicate that it cannot be regarded as a bundle of capillary tubes and that therefore *Washburn's theory of capillary flow* does not rigorously apply in this case. However, by using Poiseuille's equation modified by the assumption that the variation of moisture content does not appreciably change the kinematical resisting force, together with empirical equations derived from soil moisture studies connecting the capillary pressure and vapour pressure with the moisture content, an *equation for horizontal flow* is derived, $V = k(1 - e^{-\beta t})$, which is in qualitative agreement with experimental results. A more extended treatment of the subject is given in an article by the author in *Soil Science*. AUTHOR.

283. *Studies in Capillarity.* I. *General Considerations and Methods.* **A. Ferguson.** (Manchester Lit. and Phil. Soc., Mem. 65. 4. pp. 1–16, July 27, 1921.)—The author points out that much excellent experimental work on the subject of surface tension has suffered from a lack of coordination, and from a want of appreciation by the authors of the dynamical and mathematical principles involved.

The various methods which have been proposed from time to time for the measurement of surface tension are classified as follows :—(A) Methods independent of contact-angle. (α) *Vibrations :* (1) Vibrations of drop, (2) Waves on jet, (3) Ripples. (β) *Balance methods :* (4) Pull on ring, (5) Tension in film. (γ) *Bubbles and drops :* (6) Pressure in pendant drop, (7) Large bubbles and drops, (8) Bubbles and drops (any size). (δ) *Capillary tubes :* (9) Sentis' method, (10) Jaeger's method. (B) Methods dependent on contact-angle. (ϵ) *Capillary rise :* (11) Capillary tube, (12) Capillary plates—(*a*) parallel or (*b*) inclined, (13) Single plate, (14) Large cylinders. (ζ) *Balance methods :* (15) Wilhelmy's method, (16) Pull on sphere, (17) Pull on disc, (18) Buoyancy. (η) *Bubbles and drops :* (19) Total depth of large bubbles and drops. (C) Unclassified : (20) Drop-weight method.

In general, methods given under (B) should not be employed unless there is independent evidence that the contact angle is either zero or so small that its neglect introduces no appreciable error into the observed value of the surface tension. The results of the author's examination go to show that methods (7), (4), and (10) give good results, and furthermore that Jaeger's method is particularly convenient in practice, and, what is not always recognised, yields absolute and not merely comparative results.

Method (4) also is convenient and accurate if the theoretical conditions are observed. By bending a thin rod into a circle of large radius an anchor ring is formed, this being suspended by three threads from a balance pan so that its plane is horizontal. If the ring be allowed to touch the surface of a liquid and be then withdrawn, a distinct maximum pull will be observed, and the surface tension of the liquid may be calculated accurately in terms of this pull and the dimensions of the ring; temperature control is not difficult. Method (12*b*) has been recommended by Grummach and Bein [Abs. 1356 (1919)], and a simple and rapid method for measuring approximately the surface tension of a very small quantity of a liquid is given by Kiplinger [Abs. 655 (1920)].

Of the various balance methods classified under (B), measurement of the surface tension pull on a sphere suspended beneath a balance pan is found to be very convenient and sensitive.

Much confusion exists as to which of the problems involved in the above methods have been, and which have not been, solved, and where the problem is incapable of exact solution, needless doubts have arisen concerning the value of the approximations given and the conditions under which the approximations hold good. The author discusses the more important of such problems, and shows that, even in cases usually considered to require complex analysis, second-order corrections may be reached with the aid of simple mathematics involving nothing beyond standard differentiations and integrations.

Measurement of the tension in a liquid-liquid surface, and surface energy of solids are also discussed. T. H. P.

284. *Studies in Capillarity.* II. *Modification of the Capillary Tube Method for the Measurement of Surface Tensions.* **A. Ferguson** and **P. E. Dowson.** (Manchester Lit. and Phil. Soc., Mem. 65. 5. pp. 1–8, July 27, 1921.)—In measuring surface tension by the rise of a liquid in a capillary tube, not only is it difficult to procure a uniform piece of tubing, but the calibration, cleaning, etc., of the tubing require great care; in addition measurement of the height of ascent and estimation of the temperature of the meniscus are not easy.

Knowledge of the temperature-coefficient of surface tension permits of the calculation of the critical temperature of an unassociated liquid with considerable accuracy, since the surface tension of such a liquid is expressed very closely, from freezing-point to critical temperature, by the equation, $T = T_0(1 - b\theta)^n$, where b is the reciprocal of the critical temperature. In view of the importance of the measurement of surface tension in this connection and in work involving the use of colloidal substances, the author has investigated the possibility of devising a rapid and accurate method of measurement. He finds that almost all of the difficulties attending the capillary-rise method disappear if the pressure required to force the liquid down to the lower end of a tube immersed vertically therein is measured by means of a convenient manometer. Thus, calibration troubles are avoided, it being necessary to measure, once and for all, only the bore at the end of a capillary tube of circular cross-section. The capillary portion of the tube may be quite short, so that the tube is easier to clean and to keep clean. The thermostatic arrangements are much simplified, as the liquid may be heated electrically and temperatures measured by means of a fine thermo-couple placed quite close to the end of the capillary. Finally, the use of the cathetometer is facilitated, it being far easier to measure the difference in level of the surfaces of a liquid in the limbs of a pressure gauge than to measure the rise in a capillary tube.

The apparatus designed on these lines by the author is made in one piece, all connections being fused together, and no rubber joints used; after any determination the capillary is cut off, cleaned, and again fused into position. The apparatus and the method of using it are described in detail.

The use of benzene as a standard liquid for surface tension experiments is criticised, since immediately after purification by fractional crystallisation it gives a value of about 29·6 dynes per cm. at 15°, whereas when it is left for a few days it assumes the value about 29·9. T. H. P.

285. *Astronomical Timekeepers and Time-preserving Systems.* **K. Sôtome.** (Annales de l'Obs. Astron. de Tokyo, 5. 4. [58 pp.], 1921.)—The great humidity of Japan and its frequent earthquakes render the effect of these disturbing factors on clock-rates more important than in Europe, where most previous investigations have been made. The author has studied the practical effect of the humidity, density, temperature, and pressure of the atmosphere, and also the motive force, on the rate of chronometers. An increase in either humidity, density, or pressure, causes a chronometer to go slower. The effect of a change of temperature involves change of dimension of metal work, change of elasticity of springs, and change of consistency of the oil, but the author finds it impossible to compensate thoroughly the complicated effect, which must therefore, he thinks, be eliminated by keeping the temperature constant. The motive force, if provided as usual by a coiled spring, varies with the amount unwound. He found a marked improvement when a weight was substituted for a spring.

In regard to pendulum clocks, he finds a tendency to acceleration, especially in Dent's clocks, after comparing data from several observatories. This might be attributed in a gridiron pendulum to the non-reversibility of the heating effect on zinc, but as no seasonal variation is shown at Greenwich, the author suggests oxidation of the pendulum rod, deposit of dust on bob and rod, or attachment of fungi to the rod surface, any of which will tend to shorten the radius of gyration and thus quicken the beat. The so-called invar or nickel steel pendulum of the Riefler clock shows a slow increase in length, causing a gradual retardation of rate. Earthquake effects are next considered. In 515 cases, 3 caused the clock to stop, 28 retarded it, and 47 accelerated it; the remaining 437 having no sensible effect. Regarding the earthquake motion as a superposition of a number of simple harmonic motions of several periods and amplitudes, the author concludes that when the disturbing force has a shorter period than that of the pendulum, the result is an acceleration; and when it is longer, a retardation. He next considers the effect of air on the pendulum in three categories: (1) A hydrostatic effect; buoyancy due to displacement of fluid, diminishing the effect of gravity. (2) A second-order quantity due to resistance. (3) An increase of moment of inertia of the pendulum. Particular attention is paid to the last of these. It is found that most pendulum clocks, even when compensated, generally show an acceleration for rising temperature. The author considers it impracticable to keep the clock in a vacuum on account of the evaporation of the oil, and so suggests slightly under-compensating for temperature.

A long series of special observations of the rate of a Riefler clock has shown him that the invar pendulum gradually lengthens, that the thermal expansion coefficient is changing, and is not reversible. He suggests either quartz or tungsten as an alternative. A detailed discussion of the Washington-Paris longitude results leads him to the conclusion that the Japanese observers are rather inferior to the European and American observers.

Finally, he explains his ideal system of time preservation to provide the accuracy required in modern astronomical measurements. (1) Pendulum clock of the highest class, with perfect compensation, free escapement, and airtight apparatus. (2) At least three such clocks to be set up in cellars kept at constant temperature, separated as widely as possible, and facing different directions. (3) Each clock should be provided with a first-class chronometer and a chronograph registering both, from whose registers the relative rate between clock and chronometer would enable seismic disturbances to be detected. (4) To each of these sets, constituting a single element the method of mutual adjustment of observation and clock must be applied, to deduce the probable error of an observation. There will thus be at least three such determinations which should agree. Practically the arithmetic mean would be adopted and the rates re-adjusted. (5) Time determinations to be made as often as possible, by transit instruments with motor-driven, non-personal registering micrometer. W. W. B.

286. *A Formula for the Viscosity of Liquids.* **H. B. Phillips.** (Nat. Acad. Sci., Proc. 7. pp. 172–177, June, 1921.)—In this paper the author obtains for the viscosity of a liquid the formula, $\eta = nNh/2M(v - \delta)$, where N is the number of molecules in a mol, h is Planck's constant, M is the molecular weight of the liquid in the gas phase, v its volume per gm., and n an integer. The quantity δ is the co-volume as used in the equation of state of Keyes, $p = RT/(v - \delta) - A/(v - l)^2$. In all cases to which the formula has been applied, $n = 6$, and so the above expression takes the form $\eta(v - \delta) = 3Nh/M$. It is to be noted that 3N/M is the number of translational degrees of freedom of the molecules in the volume v of the liquid. The expression is proved in section 2 of the paper. Owing to lack of data on the equation of state, the only substances on which the formula can at present be tested are carbon dioxide, ether, and mercury. At low temperatures the measured and calculated viscosities do not differ by more than the experimental error. In the case of CO_2, the temperature 30° is too near the critical point ($t = 31°$) for satisfactory use of the equation of state. Above 10° the calculated viscosity of ether is too large, the difference increasing with the temperature. This may be due to the fact that ether is a complex of more than one type of molecule. The equation of state was determined on the assumption that each liquid molecule is formed by the combination of two gas molecules. This may be substantially true at 10° and not at 100°. To obtain values of $v - \delta$ for mercury, use is made of the fact that monatomic substances seem to have constant co-volumes δ; therefore for mercury, which is monatomic in the gas phase, δ is assumed to be constant or nearly constant in the liquid phase. Since the term $RT/(v - \delta)$ is very large for mercury, p may be neglected at atmospheric pressures, and therefore $\sqrt{[(v - \delta)T]} = 3(v - l)$, where c is constant. Below 100° the difference of the calculated viscosities and those measured is not greater than the difference between the values obtained by different observers. At higher temperatures the calculated viscosities are consistently smaller than those measured.

The observations, however, differ greatly, owing probably to oxidation of the mercury in contact with the air. The result may be to increase the viscosity to almost any amount. Tables of data are included, while Abs. 858 (1917) should be consulted. H. H. Ho.

287. *Effect of Change in the Position of a Thermometer Shelter upon the Minimum Temperature.* **H. F. Alciatore.** (Monthly Weather Rev. 49. pp. 339–340, June, 1921.)—The thermometer screen at Escondida, Cal., having been moved to a position about 20 ft. higher, a short horizontal distance away, it was desired to know the effect produced on the recorded minimum temperatures. The months Nov. to Feb. are considered, for three seasons before and two seasons after the change. The minima before and after are compared by considering their departures from those at a station 15 miles away and eliminating the difference before and after at this station. The effect was to raise the minima recorded at Escondida by 2·5° F. on the average. During Nov. and Feb. the effect was much more marked on mild mornings than on mornings with minima of 32° F. and below, when the increase was very slight. M. A. G.

288. *Effects of Earth Cooling.* **H. Jeffreys.** (Roy. Soc., Proc. 100. pp. 122–149, Nov. 1, 1921.)—*Mountain Building.*—The thermal history of the earth is reconsidered on the assumption that the earth was once molten. The compression of the crust due to cooling is found to be 2½ times that required to account for all the existing mountains, but consideration of sub-oceanic conditions shows that this surplus is not really great. The Pacific type of mountain range is explained by the greater cooling and strength of sub-oceanic rocks. It is shown that the mechanism of isostatic compensation cannot be caused by the effects of pressure in changing the density of matter, but must consist in the partial replacement of a dense material by a lighter. Further considerations shows that this flow of matter must take place some distance below the layer of compensation.

Origin of Continents.—The inequalities that give rise to land and water hemispheres are first harmonic deformations and are compensated, merely as a necessary consequence of the law of gravitation itself. The stresses set up in the earth's crust after consolidation would produce a polygonal system of cracks, and the behaviour of the blocks so isolated provides a mechanical theory for the origin of continents, which receives some support from a consideration of features on the surface of the moon. W. A. R.

289. *Pack Ice.* **J. M. Wordie.** (Roy. Soc. Edinburgh, Trans. 52. pp. 795–829, 1920–1921.)—A long series of observations on the history of Antarctic pack ice, obtained in the *Endurance* (1914–1917), is given, prefixed by a glossary of terms. The actual course among the ice-fields exceeded 2000 miles. The Antarctic pack is not essentially different from that of the Arctic. In the early stages of formation the sea becomes filled with platy crystals; on aggregating in many cases a complex sheet is formed in the centre of which the plates are more or less vertical, and at a later stage the ice is characterised by horizontal banding due to layers of different density, whose formation depends on the rate of freezing. The formation is described both in calm and rough water. The ice is in continual motion; cracks and other structures are formed by sudden temperature changes, unequal loading, and lateral pressure generally due to wind. The pressure caused "hummocking" of the ice. The track of the drift ice was influenced by three factors: wind, the left-hand component of the earth's rotation, and true currents. The winds commonly met with off the Antarctic coasts are south-easterly, with the result that the ice pack moves to the west. The max. thickness of one-year ice was 5 ft. During the summer diatoms make their way into the upper surface of the ice, giving it a yellow colour. A discoloured band, therefore, marks the interval between two periods of freezing. Ice takes one-half the heat required to melt snow; and the ice suitable for yielding fresh water was clear, with conchoidal fracture, blue in colour and spotted. This structural change from the fibrous to the spotted type was found to be due to high summer temperatures, and may take place while the ice is still afloat, but reaches its fullest development when the ice had been subjected to a summer temperature as a hummock above water-level. The amount of chlorine initially enclosed depended on the rate of freezing, and the ice gradually loses its Cl content. The Cl moves downwards, and is not "squeezed" out at the surface. The winter loss was insignificant compared with that taking place during summer. Surface melting is not an important factor in the Antarctic as it is in the Arctic. In the Weddell Sea the most important factor of decay is the swell, which breaks down the floes into small pieces. Mechanical erosion then operates by the washing of sea water against the ice; and finally, when the temperature allows, the ice blocks are destroyed by melting. W. A. R.

290. *Forms of Planetary Orbits on the Theory of Relativity.* **W. B. Morton.** (Phil. Mag. 42. pp. 511–522, Oct., 1921.)—An exact integral of the differential equation for a planetary orbit on Einstein's theory can be expressed by the use of elliptic functions [see Abs. 1125 (1920)], and the forms assumed by these orbits in the most general case are examined from the purely mathematical aspect. With increase of velocity in the orbit, paths corresponding to the parabolic and hyperbolic paths of the old theory would be obtained, whilst it is found that decrease of velocity leads to orbits of a new type which pass through the centre. These "captured" orbits are studied mathematically and typical resulting orbits are shown in diagrams and summarised in tabular form. In the case of the sun and earth the critical velocity for capture is $4 \times 10^{-8} \times$ speed of light $= 12$ metres per sec., or about 1/2500 of the orbital velocity. A. B. C. L.

291. *The Weddell Sea.* **J. M. Wordie.** (Roy. Soc. Edinburgh, Trans. 52. pp. 781–793, 1920–1921.)—In the early part of the voyage the *Endurance* (1914–1917) was on ground partly covered by the *Scotia* and supplemented the work of Bruce off Coats Land. Later her track crossed that of the *Deutschland* at right angles and lay on new ground to the west of all previous routes.

Deposits.—The deposit was everywhere terrigenous in origin, and the term "glacial mud" is employed. A deposit that could be called sand rather than mud was unusual. Deposits on the continental shelf were of similar character to those in deeper water. The pebbles and boulders dredged included a variety of igneous rocks, a Cambrian limestone, sandstones, and shales. The latter were glacially striated. The source of the material was from the east, but the data are insufficient to determine whether Coats Land is similar to Victoria Land or to Graham Land, but the balance of probability is in favour of the former alternative.

Bathymetrical Results.—The *Endurance* drifted right across the unknown tract called New South Greenland, or Morrell Land, and deep soundings were obtained. The behaviour of the contours makes the existence of this land highly improbable. In the neighbourhood of the Wilhelm barrier a deep channel is indicated. The continental shelf off Coats Land is comparatively narrow, and the existence of a series of stepped terraces running N.E.–S.W. was proved. These features can be explained by faulting, and it is probable that the deep Antarctic shelf is the result of earth movement rather than erosion. A complete table of soundings is appended. W. A. R.

292. *Displacement of Star Images near that of the Sun.* **A. Kopff.** (Phys. Zeits. 22. pp. 495–496, Sept. 1, 1921.)—The author attributes the result obtained by E. Lihotsky [Abs. 1538 (1921)], which is in conflict with Einstein's conclusion, to an error in the former's calculations arising from g_{44} having been taken by him as representing the gravitation potential when it should have been $\frac{1}{2}g_{44}$. G. W. de T.

LIGHT.

293. *Instrument for Measuring Visibility.* **A. Wigand.** (Phys. Zeits. 22. pp. 484–487, Sept. 1, 1921.)—Describes a modification of an instrument previously described [see Abs. 1000 (1919)] for the measurement of the opacity of the atmosphere, by the observation of objects at a given distance and the insertion of ground-glass screens of various opacities. If the most transparent screen is numbered 1 and has approximately double the lowest limit of opacity perceptible to the eye, it is found that with this old instrument, the object vanishes when a screen equivalent to 14·3 of these unit screens is interposed. The new instrument enables a continuous reading to be obtained with a single screen only. The visibility of objects seen behind a ground-glass screen diminishes as the distance between the objects and the screen is increased, i.e., as the spread of the rays from any given point on the object before they reach the screen is increased. The visibility can therefore be varied continuously either by changing the distance between the test object and a single screen, or by inserting an iris diaphragm of variable opening between the two. The latter scheme is more convenient and is adopted in the present instrument. J. W. T. W.

294. *Recording Microphotometer: Application to Accurate Length Measurements.* **F. Goos.** (Zeits. Instrumentenk. 41. pp. 313–324, Nov., 1921.)—Describes a development of the instrument previously described by Koch [see Abs. 400 (1913) and 1824 (1914)] for recording on a single diagram the curve of variation with distance of the opacity of a material, *e.g.*, a photographic film, along any given direction. The method of obtaining satisfactory slow motion for the bed holding the material is described in the present paper. This motion is made, by means of a tilting mirror with a long arm, to communicate a motion, along one axis of the recorder plate, of the image of a portion of the filament of a string galvanometer. The amount of light passing through the specimen falls on a photoelectric cell and this causes a lateral deflection of the filament, so that the record obtained is a graph of the transparency against length in the direction of motion of the table.

The author suggests that this method may be used for the accurate determination of the exact centres of lines such as those of a grating ruled on glass. J. W. T. W.

295. *Determination of the Path of Aerial Objects; Apparatus.* **H. Fuss.** (Zeits. Instrumentenk. 41. pp. 281–289, Oct., 1921.)—Describes Bamberg's theodolite which, by means of a moving photographic film, enables a record of the position of an aerial object to be obtained at intervals of half a second or less. By means of a key, at the instant when the object is correctly sighted in the telescope, a photograph is taken of the scales of the theodolite. When the key is released the film containing the record is moved forward so that another exposure may be made, and thus if the object be carefully followed with the telescope

a very complete record of its path may be obtained. The apparatus has the advantages of compactness and light weight, as well as simplicity in use and accuracy, the angles being readable to the nearest 0°·01. Full details of the electrical circuit used for the registering apparatus, and an example of a series of actual observations are given in the paper.
J. W. T. W.

296. *Laboratory Apparatus for Hartmann's Method of Focusing Astronomical Cameras of Long Focus.* **J. Baillaud.** (Bull. Astronomique, 1. No. 4. pp. 213–223, 1921.)—Describes a method of obtaining two parallel rays of light for focusing by Hartmann's method. A description of this method is given. The two rays are produced by two plates pierced with two holes exactly similarly placed, a source of light being situated behind each hole in one of the plates. The error introduced by different errors in the relative positions of the holes (i.e., lack of parallelism of the rays) is discussed theoretically and an example of the use of the method is given.
J. W. T. W.

297. *Improvements to Seemann's Spectrograph.* **A. Weber.** (Zeits. f. Physik, 4. 3. pp. 360–362, 1921.)—Describes improvements with a view to precision measurements.
E. H. B.

298. *Absorption Coefficients of Solutions for Monochromatic Radiation.* **E. O. Hulburt** and **J. F. Hutchinson.** (Carnegie Inst. Publ. 260. pp. 6–69, 1918. After Chem. Abstracts.)—Solutions varying from saturation to moderate dilution, in water and in some alcohols, are prepared of cobalt nitrate and sulphate; nickel chloride, nitrate, sulphate; ammonium ferric alum; chromic chloride, nitrate, sulphate; potassium permanganate. The absorption coefficients are determined for the spectrum range 600 $\mu\mu$ to 1300 $\mu\mu$ in steps of 20 to 40 $\mu\mu$. The molecular absorption coefficient A is calculated for each wave-length and plotted against the concentration in gm.-molecules. In general A is not found constant; the deviations from the constant value are generally small, except for certain points situated at the edges of absorption bands. In the case of cobalt chloride the curves for the alcohols (ethyl, propyl, isopropyl, and isoamyl) were similar. No theory adequately explains the observations.
H. B.

299. *Absorption of Light by Gases (Bromine).* **G. Ribaud.** (Ann. de Physique [ix.] 12. pp. 107–226, Sept.–Oct., 1919.)—A general study of the subject and especially of the little-studied continuous absorption of light in the ultra-violet by gases, particularly by bromine and other halogens. The apparatus used is briefly described. The bromine vapour is, *e.g.*, contained in a cylindrical chamber, closed at both ends by quartz plates; by two capillaries the chamber communicates with the interior of the surrounding brass vessel, in which the pressure of CO_2, H, O is raised (to 100 atmos.); temperatures are pushed up to 620°. In measuring the width of the bands one of the foreign gases is added to the gas in question, and the pressure is increased, until the bands cease to be distinct. To explain anomalous dispersion a force of friction is introduced: $mr\,dx/dt$, where r is the coefficient of damping (amortissement) and x the displacement of the oscillating corpuscles. The coefficient of damping is found to be proportional to the pressure in all portions of the absorption curve;

with increasing pressure the maximum wave-length does not change in the ultra-violet, but the coefficient of absorption diminishes slightly; this is in not accord with observations in the infra-red. The experimental curves show systematic divergencies from the theoretical curves based upon the electromagnetic theory of absorption. The kinetic theory does not apply to the broad, contiguous regions of absorption; the mechanism of absorption must be sought in the molecule itself, and the damping can probably be explained by the disturbances of the electron in the interior of the molecule; it could then be understood why the breadth of the bands increases as we pass over to the infra-red. The rule of Königsberger that the breadth of a band is proportional to the square root of the absolute temperature—later withdrawn (?), it is said, by Burger and Königsberger [Phys. Zeits. pp. 725–726 (1913)]; this refers to the damping, however—is rejected. The last part of the paper shows that the absorption by bromine-rays is in accord with the kinetic theory of absorption, the mobile corpuscle containing the electron being the molecule itself. As regards the magneto-optic properties of bromine and iodine, reference is made to the experiments of the author and of R. W. Wood [see Abs. 1536 (1914)] as to the extremely feeble Zeeman-effect in the neighbourhood of absorption rays. H. B.

300. *The Candle Flame as a Turbid Medium.* **H. Senftleben** and **E[lisabeth] Benedict.** (Kolloid Zeits. 26. pp. 97–100, March, 1920.)—The narrow beam of an arc lamp is thrown on a Hefner (pentane) lamp. The intensity of the scattered light increased by 300 per cent. as the angle between the incident beam and the direction of observation increased from 45° to 150°, and the polarisation was a maximum (86 per cent. of the incident light) at 90°. The intensity of the scattered light was greater for short-wave light than for long waves, and the absorption decreased therefore with increasing wave-length. The effects being due to the small particles of incandescent carbon, this was rather surprising, since the absorption by massive carbon is almost independent of wave-length. According to Rayleigh the absorption of light by a flame should vary inversely as $\lambda^{1\cdot4}$; but the candle-flame does not satisfy the conditions of Rayleigh. Mie's formula for the propagation of light through turbid media would show that the carbon particles in the flame, if spherical and not crowded, have a diameter of about 175 $\mu\mu$. The estimate of $9\cdot8 \times 10^8$ particles per cm.^{3} of flame would agree with A. Becker's estimate of 1906 of the soot deposited by a flame. H. B.

301. *Scattering of Radiation by the Carbon Atom.* **R. Glocker.** (Zeits. f. Physik, 5. 1. pp. 54–60, 1921.)—Dealing in a previous paper [Abs. 995 (1921)] with the scattering by atoms of aluminium and carbon, the author had presumed that the atom was built up of coplanar rings of electrons. This assumption having been criticised, he discusses the influence of other spacial arrangements of the electrons. Landé places the four vortex electrons at the corners of a pulsating tetrahedron, and lets them describe approximately circular orbits, the radius r of the ring being $r = a_0 n^2/(Z - 0\cdot96)$, where a_0 is the radius of the innermost circle of Bohr in the hydrogen atom, n the number of quanta, and $Z - 0\cdot96$ the effective core change, Z being equal to 4 for the external shell of the atom. The two inner electrons would describe coplanar rings. This view would chemically be acceptable. The author shows that the interference effects of the scattering by this arrangement would nearly be the same as with the Bohr atom, so that scattering-measurements would not enable us to discriminate. In the Landé model the four electrons would, after describing an arc of 60°, all be in the same plane at the corners of a square of radius $r/\sqrt{2}$, as in a Bohr atom. In the other configurations of the Landé model the sums of the distances of the outer electrons from the inner electrons would not vary much, even if the orbits were elliptical, provided the shell be at considerable distance from the inner ring. That latter assumption is connected with $n = 2$. Calculating the scattering curves for an outer shell of $n = 2$, and for an inner ring of 6 electrons, and $n = 1$, the author finds that Barkla's measurements agree with the former curve, whilst an outer shell of $n = 1$ would come nearer the latter. It is pointed out that both the theory of scattering and the measurements should be perfected. H. B.

302. *Dispersion of Light by Potassium Vapour ; Temperature Influence.* **M[arion] Baxter.** (Phil. Mag. 42. pp. 289–302, Sept., 1921.)—The author describes an investigation of the effects of temperature on the relative values of the constants a_1, a_2 in the dispersion formula $\mu^2 - 1 = a_1\lambda^2/(\lambda^2 - \lambda_1^2) + a_2\lambda^2/(\lambda^2 - \lambda_2^2)$, since definite experimental evidence on this point is important in connection with the nature of the systems which give rise to spectral lines.

After describing the experimental procedure adopted in the examination of the dispersion of the principal lines of potassium vapour, the tabulated and graphical results of the observations are given. These tables indicate clearly that the ratio a_1/a_2 shows a definite *decrease* with rising temperature. This is contrary to what would be expected if different specialised atoms were engaged in the absorption of the different lines. A. B. W.

303. *Dispersion in Optical Glasses.* **F. E. Wright.** (Optical Soc. of America, J. 5. pp. 389–397, Sept., 1921.)—A continuation of previous work on this subject [see Abs. 1269 (1920)], in which it is shown that for all ordinary optical glasses there is a linear relation between the partial dispersions at any two different parts of the spectrum ; for instance, $n_y - n_x = a(n_F - n_C) + b$. The present paper gives average values for a and b at different wave-lengths x and y. An extensive table based on these values gives the values of $n_C - n_{A'}$, $n_D - n_C$, $n_F - n_D$, and $n_{G'} - n_F$ for values of $n_F - n_C$ at intervals of 0·0001 from 0·0050 to 0·0300. A table of comparison between the partial dispersions of glasses listed by Parra-Mantois, and those found from the above table shows that the differences do not exceed a few units in the fifth decimal place, except in a few cases. It is found that boro-silicate flints show an increased partial dispersion in the red and a decreased partial dispersion in the blue. Barium flints show small decreases in both red and blue. The barium crowns show an increase in refringence relatively in the red, and an appreciable decrease in the blue, while in the borosilicate crowns there is a slight increase in both the red and the blue. In the ordinary crowns there is a slight decrease in the red, and a slight increase in the blue. The fluor crowns are remarkable for a relatively large increase in the blue with slight decrease in the red. It is demonstrated that, so long as the glasses remain colourless, they differ chiefly in the relation between partial dispersion and absolute refractive index ; the relations between the partial dispersions at different regions of the spectrum are practically invariable. J. W. T. W.

304. *Refractometry of Liquids at High Temperatures.* **F. R. v. Bichowsky** and **H. E. Merwin.** (Optical Soc. of America, J. 5. pp. 441–443, Sept., 1921.)—Describes the preparation of silica-glass prisms designed for the high-temperature refractometry of liquids, and the electric furnace used in the experiments. Results are tabulated for glacial acetic acid 99·5 %, α-monochlornaphthalene, 95–96 % H_2SO_4, and sulphur. The temperature range covered was from room temperature to 300° C. J. W. T. W.

305. *Microscope Slow Motions.* **H. Boas.** (Zeits. Instrumentenk. 41. pp. 299–304, Oct., 1921.)—Describes an investigation of the errors to be found in the slow-motion indication of large microscopes of two different constructions. In the case of one instrument positions were found in which the motion indicated was more than double that made, while in others the motion was actually slightly retrograde for a forward motion of the head. The second instrument was found to give a much better performance. J. W. T. W.

306. *Definition of Night Glasses.* **G. Gehlhoff.** (Zeits. techn. Physik, 2. 9. pp. 245–250, 1921.)—Gives figures for the threshold value of the retinal illumination necessary to produce the sensation of vision with images of various angular dimensions: (*a*) for the rods, and (*b*) for the cones. These figures are exhibited in the form of curves. It is shown that up to an angle of vision of about 5′ for the cones and 10′ for the rods, the amount of illumination required rises rapidly with decrease of angle. It is thus shown that with faintly illuminated objects, the use of night glasses of a certain degree of magnification may bring the object within the region of visibility by increasing the size of the image to such an extent that its illumination is above the minimum required for visibility. The use of glasses may also be of advantage if it enables more detail to be seen, and so increases the chance of recognition of the object observed. J. W. T. W.

307. *Spherical Correction of Photographic Objectives.* **K. W. F. Kohlrausch.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 6. pp. 609–631, 1920.)—A general discussion of the methods of measuring the spherical aberration of photographic lenses, and a description of a rapid method capable of giving the position of the focus for any ray to 0·01 mm. The paper concludes with extensive tables giving the characteristics of a large number of specimens of the chief types of photographic objectives. J. W. T. W.

308. *Method of Improving the Visibility of Distant Objects.* **C. V. Raman.** (Nature, 108. p. 242, Oct. 20, 1921.)—It is stated that the power of distinguishing detail in a distant object, and especially of perceiving it in its natural colours, may be improved considerably by the simple device of fitting a small Nicol prism in the eyepiece end of the observing telescope. The nicol serves to cut off a great deal of the blue atmospheric "haze" which usually envelops a distant view and mostly consists of polarised light. Details, which are usually lost in the haze, such as the colour of distant rocks or vegetation, then stand out in a striking way. The visibility of the horizon at sea, especially in a haze, may often be much improved by a similar device. In this case the result is due in part to a suppression of the reflection from the surface of the water as seen through the Nicol prism. A. W.

309. *Stereophoto Surveying.* **H. Lüscher.** (Zeits. Instrumentenk. 41. pp. 262–272, Sept., 1921.)—Considers the various cases with camera axes in a horizontal plane, viz. axes parallel and perpendicular to base, axes parallel but inclined to base, axes convergent. Any other case may be regarded as a combination of the last two. The position of any point is determined from the image positions by a combination of calculation and graphical methods described in the paper. J. W. T. W.

310. *The Light-Quantum.* **R. Emden.** (Phys. Zeits. 22. pp. 513–517, Sept. 15, 1921.)—A concise summary of the quantum theory of energy distribution, with the deduction of the Wien displacement law and the Planck formula of energy distribution, and its application to the Doppler-effect and polarisation. The number of quanta in 1 cm.^{3} of sunlight (assumed monochromatic at 0·470 μ) at the surface of the earth is computed to be 10^7. J. W. T. W.

311. *Theory of "Photophoresis."* **S. Ray.** (Ann. d. Physik, 66. 1. pp. 71–72, Oct. 27, 1921.)—Points out theoretical difficulties in treating this phenomenon on the basis of the radiometer effect. E. H. B.

312. *New Experiments on Photophoresis.* I. **J. Mattauch.** (Akad. Wiss. Wien, Ber. 129. 2A. Nos. 9 and 10. pp. 867–893, 1920.)—The experiment on the photophoresis of selenium was carried out under more intense illumination than before. The speed of the particles and the forces on them were measured. The smallest light-positive test particle with red light was of radius $a = 18 \times 10^{-6}$ cm. For light-negative test particles no effect could be observed except for radii less than 17×10^{-6} cm. The force on these particles attained its maximum for $a = 14{\cdot}5 \times 10^{-6}$ cm. The paper abounds in tables and graphs, and should be consulted for the full details. [See Abs. 745 (1919).] E. H. B.

313. *Optical Determination of Size of Ehrenhaft's Test Particles.* **E. Norst.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 7. pp. 673–682, 1920.)—By means of optical resonance experiments and Mie's resonance curves the order of magnitude of the particles in question may be determined. A number of such results are given in a table in which the radius a varies from $(8 \text{ to } 20) \times 10^{-6}$ cm. [See Abs. 1272 (1919).] E. H. B.

314. *Temperature Correction for Harcourt Pentane Lamp.* **E. B. Rosa, E. C. Crittenden,** and **A. H. Taylor.** (Optical Soc. of America, J. 5. pp. 444–452, Sept., 1921.)—The value of the humidity correction for the candle-power of the pentane lamp has consistently been found to have the value 0·57 % per litre of water-vapour in America, and 0·63 to 0·66 in England and Japan. In explanation of this it has been suggested that this correction factor is, in reality, a combination of both humidity and temperature corrections which cannot be readily separated since temperature and humidity are more or less connected. However, the law connecting them is different in America from that found in England. In the former case it is 0·6 deg. C. per litre, and in the latter 1·6 deg. C. per litre. It follows that a temperature coefficient of 0·08 % candle-power decrease per degree rise of temperature would account for the discrepancy noticed. Assuming this to be the case, the true humidity coefficient may be shown to be 0·52. Experiments in which the humidity was variable without appreciable change of temperature gave a value of 0·523, so that it is proposed that a mean temperature of 15° C. should be adopted as standard condition, and the temperature correction factor introduced. J. W. T. W.

315. *The Rayleigh Law of Emission and the Velocity Distribution of the Conducting Electrons.* **E. Kretschmann.** (Ann. d. Physik, 65. 8. pp. 720–734, Oct. 13, 1921.)—A mathematical paper, dealing with the effect of the Maxwell law of velocity-distribution on the Rayleigh law of spectral emission in long wave-lengths. [See Abs. 709 (1916).] J. W. T. W.

316. *The Arc Spectrum of Terbium. "Welsium."* **J. M. Eder.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 5. pp. 421–436, 1920.)—The many hundreds of fractionations of Auer v. Welsbach did not finally settle the question whether or not there might be an element between gadolinium Gd and terbium Tb. Urbain's terbium, serving for the atomic weight determination, was not pure; Eberhard's spectra had been determined with Urbain's salts. Exner and Haschek (1910) ascribed a number of lines in the Tb spectrum to a hypothetical element E between Gd and Tb. Experimenting with various terbium fractions of Auer v. Welsbach, transformed into chlorides and volatilised in the carbon arc, the author finds that the E lines can all be traced to Gd or to Tb, and that there is no intermediate element on that side of terbium.

There are, however, a great many lines due to a new element for which the name "Welsium" is proposed, between terbium and dysprosium; the author tabulates more than 300 welsium lines between λ6546 and 3038; the wave-lengths of the Tb lines are not given. The flame arc is coloured red by gadolinium, yellowish-white by terbium, and greenish by dysprosium [compare Abs. 104 (1920)]. H. B.

317. *Emission Spectra and Chemical Reactions in the Source of the Radiations:* **A. del Campo.** (Anal. Fis. Quim. 17. pp. 247–270, Oct., 1919.)—The discrepancies in the spectra of various observers may be due to chemical reactions, notably oxidation and reduction, taking place in the arc, where they are localised and then sometimes called "polar" effects. Thus the silica spectrum shows variations across the arc due to the sub-oxide SiO. The green bands of Mg are due to the sub-oxide Mg_2O. Natural calcium carbonates (aragonite) show three new lines, 2554·6, 2563·8, 2565·0, which are really due to Ca, and not to impurities, though they are not visible in the pure hydroxide. The oxide is always reduced to metal by the carbon of the arc, and the metal is re-oxidised; in the presence of CO_2, however, the metal persists so that the feeble lines are seen. This is confirmed by other experiments. H. B

318. *New Lines in the Arc Spectrum of Silver, λ4500 to λ4300 Å.U.* **M. A. Catalán.** (Anal. Fis. Quim. 15. pp. 483–486, Dec., 1917.)—The arc is formed between silver electrodes, 10 mm. in diameter, by currents of 12 amps. at 20 to 40 volts. In the tables the spark spectra of Eder and Valenta are given for comparison. There are 80 new lines in the range mentioned. H. B.

319. *New Lines in the Arc Spectrum in Air, of Iron, λ2300 to λ1980 Å.U.* **S. Piña de Rúbies.** (Anal. Fis. Quim. 15. pp. 434–444, Nov., 1917.)—More than 288 new lines are tabulated, comparison being made with the tables of Dewar and Liveing, and of Kayser. H. B.

320. *New Lines in the Arc Spectra of Nickel and Cobalt, λ2300 to λ2000.* **S. Piña de Rúbies.** (Anal. Fis. Quim. 16. pp. 338–350, March, 1918.)—The new 66 lines of Ni and 165 of Co are compared with those of Liveing and Dewar, and of Exner and Haschek. H. B.

321. *Reduction Spectra, particularly of Magnesium and its Compounds.* **J. Meunier.** (Soc. Chim., Bull. 25. 26. pp. 562–565, Oct., 1919.)—Continuing the experiments mentioned in Abs. 1026 (1920) [where Vol. 28 should read 25], the author, using one prism only, studies the spectra in a flame of commercial hydrogen, especially the rays of the bands in the ultra-violet from λ3700 upward. The chloride, oxychloride, sulphate, nitrate, oxide, and carbonates (not the pyrophosphate) of magnesium, give the same lines as the metal. Certain other bands, λ4702 and 5003, generally ascribed to MgO, are also observed in Mg. On the other hand, the author has never observed the triplet b_1, b_2, b_4. The spectra are only described; there are no photographic reproductions. H. B.

322. *Electronic Structure and Spectra of Heavy Atoms.* **A. Dauvillier.** (Comptes Rendus, 173. pp. 647–649, Oct. 17, 1921.)—A continuation of previous work [Abs. 1995 (1921)]. The present paper deals with gold, platinum, iridium, osmium, and tungsten. The same experimental arrangements were employed as in the earlier work, and a detailed study was made of the L series, particular attention being paid to the variations of intensity of certain homologous lines. Six new lines have been obtained, making a total of 14 new lines found in the course of this research. It was found that for each of the elements mentioned above, the lines β_5 and γ_2 always had intensities nearly the same, and the intensity increased *regularly* from W to Pt, but remained constant beyond that element. The results for the whole series are presented in tabular form, and are briefly discussed with respect to the electronic structure of the atoms of the elements dealt with. A. W.

323. *Absorption of Light by Electrically Luminescent Mercury Vapour.* **E. P. Metcalfe** and **B. Venkatesachar.** (Roy. Soc., Proc. 100. pp. 149–166, Nov. 1, 1921.)—Experiments with mercury vapour at low pressures, rendered luminous by the passage of small electric currents, are described, and it is shown that under such conditions the mercury vapour exerts powerful selective absorption. Of the series lines which are absorbed, those belonging to the first and second subordinate series of triplets exhibit heavy absorption. Photometric observations of the absorption and emission of the line λ5461 by columns of mercury vapour of different lengths and carrying different currents showed that a linear relation existed between the ratio Emission/Absorption and the current density. The applicability of the Stewart-Kirchhoff law to bright-line radiation is discussed, and it is shown that the complexity of a line may have a great influence on its absorption. In certain experiments the lines λ5461 and λ4359 were obtained reversed, so as to appear as dark lines on the continuous spectrum of the carbon arc or of the sun. A detailed study of the reversal of λ5461 was made with a Fabry and Perot étalon, and also with an echelon spectroscope. A. W.

324. *Absorption Spectra of Triphenylmethane Dyes.* **E. Adinolfi.** (Accad. Sci. Fis. e Mat. Napoli [Ser.3], 27. pp. 242–247, 1921.)—Examination of the absorption spectra of a number of triphenylmethane dyes dissolved in various solvents shows that, starting from aqueous solutions, the halochromy exhibited by compounds of this series becomes increasingly marked as the molecular weight of the solvent increases. Kundt's law, according to which the absorption bands are displaced towards the red end of the spectrum on passing from one solvent to another more highly refractive, is not applicable to the triphenylmethane group, the displacements being greater for ether than for ethyl alcohol and greater for benzene than for toluene. T. H. P.

325. *Absorption of Light by Elements in a State of Vapour.* **J. J. Dobbie** and **J. J. Fox.** (Roy. Soc., Proc. 99. pp. 456–461, Sept. 1, 1921.)—Plates showing the absorption spectra of the halogens from ordinary temperatures to 1350° C. are reproduced and their characteristics compared with vapour-density records. The experimental details observed in the production of the spectra are given. It is stated that, as in the case of sulphur, it is equally impossible to explain the changes in absorptive power of the halogens on the hypothesis that the diatomic molecules are gradually broken down into monatomic molecules, and that no other change takes place. The association of the temperature of max. absorption with a tendency to polymerise is not only in accord with the varying valencies of the halogens, but also brings the phenomena into line with those exhibited by sulphur, which are almost certainly connected with the tendency of this element to undergo polymerisation. A. B. C. L.

326. *Destruction of Phosphorescent Zinc Sulphides by Ultra-Violet Light.* **L. B. Loeb** and **L. Schmiedeskamp.** (Nat. Acad. Sci., Proc. 7. pp. 202–207, July, 1921.)—For the preliminary experiments described three different samples of phosphorescent zinc sulphides were used; one an American sample, the other two obtained from France. The specimens were prepared by sifting the fine crystals upon small circular plane glass plates 7 mm. in diam. which had been moistened with a very dilute solution of collodion in amyl acetate. The glass plate was fastened to a plate of thin transparent quartz and the back of the glass plate was painted with optical black. A control specimen was similarly mounted on a glass microscopic slide.

The quartz-mounted specimen was then placed in the image of a quartz Heraeus mercury arc thrown upon the wall by a quartz lens of 3-cm. aperture and 15-cm. focal length. The arc operated continuously at about 2·5 amps. in a light-tight box. The rise in temperature indicated by a blackened thermometer bulb placed in the image of the arc was only 0·5 deg. C. The glass-mounted control sample was kept in a light-tight box except at the time of photometric measurement. The phosphorescent intensities of the quartz-mounted specimen and the control were compared by photometric measurements on the phosphorescence exhibited by them when studied in a simple phosphoroscope. After the quartz sample had been exposed to ultra-violet light for a suitable interval of time its intensity was compared with the control. Tables of the intensities of the three specimens compared with that of the control after various intervals of time are given, and from these it appears that in every case there is a marked reduction in the phosphorescent intensity with the increase in time of ultra-violet illumination. One specimen dropped to one-fourth of its initial intensity after 300 hours in the image of the arc. The presence of chlorine gas to a slight extent in the air of the room arrested the decrease of intensity. The reduction of intensity of the phosphorescence was in all cases accompanied by a darkening of the sulphide. Experiment showed that the blackening was not due to the collodion. The experiments indicate that the action of intense ultra-violet light causes a destruction of the phosphorescent power of the zinc sulphides and that this destruction is accompanied by chemical changes resulting in a change of colour in the sulphides. This destruction of phosphorescent power may point to a close analogy between the phenomena of phosphorescence and fluorescence, in the light of the recent work of Perrin. J. J. S.

327. *"J" Radiation.* **J. A. Crowther.** (Phil. Mag. 42. pp. 719–728, Nov., 1921.)—A discussion is given of the possible existence of fluorescent X-radiations of a considerably shorter wave-length than the well-known K series of radiations, and experiments are described which tend to prove the existence of such radiations. A. W.

328. *Theory of X-Ray Spectra; Electron Systems in the Atom.* **A. Smekal.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 7. pp. 635–660, 1920.)—A theoretical discussion of the mechanism of atomic structure, based on the Bohr-model, with particular reference to X-ray spectra. A. B. W.

329. *Scattering of Rays in X-Ray Diffraction.* **S. J. Plimpton.** (Phil. Mag. 42. pp. 302–304, Sept., 1921.)—Reasons are given for assuming that the mechanism of scattering of X-rays by matter is not so simple as is generally supposed, but involves a more indirect process such as absorption and re-emission of energy. On account of its great theoretical importance the author has examined this point with considerable care, and experiments are now described with this object in view. Since further, more detailed, experiments are to be made with a new apparatus specially designed for the purpose, the author does not state his conclusions. A. B. W.

330. *X-Rays and their Industrial Applications.* **G. W. C. Kaye.** (Soc. Arts., J. 69. pp. 743–751, Sept. 23; 757–769, Sept. 30, and pp. 771–782, Oct. 7, 1921.—Cantor Lectures.)

331. *Wave-Lengths of X-Rays.* **R. W. G. Wyckoff.** (Washington Acad. Sci., J. 11. pp. 366–373, Sept. 19, 1921.)—Taking the case of sodium chloride as an example, it is shown that there are other structures, besides the commonly accepted "sodium chloride arrangement," which are in agreement with the *present* experimental data. As a result of this lack of definiteness it is emphasised that it is more logical to consider the value of the wave-lengths of X-rays as being based upon the quantum hypothesis. A. B. W.

RADIO-ACTIVITY.

332. *Passage of Corpuscular Rays through Matter and the Structure of the Atom.* **R. Seeliger.** (Jahrb. d. Radioakt. 16. pp. 19–65, Sept. 18, 1919.)—A critical review of the work on the changes brought about by α- and β-rays, kathode and canal rays, referring as to electrons mainly to Lenard (Heidelberg Akad., Abh. 1918, No. 5), and as to α-rays and the model atom chiefly to Rutherford and his pupils. The terminology of Lenard is used. The author warns against bold speculation. The strong deflections in some of C. T. R. Wilson's photographs might possibly be perspective effects (Lenard); that should be tested by photographing on two plates at right angles to each other. The electrons certainly play a part in similar phenomena in which they are disregarded. Quite slow electrons, at velocities below the ionisation potential, are reflected by solid walls and by the rare gases, also nitrogen (Lenard), as if the gases were elastic; in other gases the loss of velocity is the greater the more negative they are. The sections of the paper deal with changes in the moving particle (direct conveyance of kinetic energy to the atom and emission of electromagnetic radiation), and with changes in the atom (gain in kinetic energy, emission of electromagnetic and of secondary corpuscular radiation and chemical changes). H. B.

333. *Radio-Activity of the Rocks of the Kolar Gold Fields.* **H. E. Watson and G. Pal.** (Ind. Inst. Sci., J. 1. pp. 39–46, 1914.)—The rocks from the fields on the Mysore plateau are uniform, probably very old schists; the temperature gradient in the mines, worked to 1100 m. depth, is very small, and the amount of radium estimated to be in the schists, $0{\cdot}19 \times 10^{-12}$ gm. Ra per gm. of rock, is likewise very low. In other rock specimens the Ra figure went up to 6·9. The authors fuse the schist with caustic potash under reduced pressure in a copper flask, and thus liberate the emanation at lower temperature than when working with the carbonate. Some hydrogen was also liberated, and had to be burnt out (by passing the gas over glowing copper oxide) before allowing the gas to enter the electroscope. H. B.

334. *Radio-Activity of Bavarian Rocks and Waters; Fluorspar of Wölsenberg.* **F. Henrich.** (Zeits. angew. Chem. 33. pp. 5–8, Jan. 6; 13–14, Jan. 13, and pp. 20–22, Jan. 20, 1920.)—Examination is made of rocks and spring waters from the Franconian Switzerland and the Fichtelgebirge, in Northern Bavaria. The springs in chalk are feebly active, those in granite more radio-active; the latter rocks contain tobernite and autunite, and the gases 12 % of oxygen. The Stink fluorspar from Wölsenberg, blue and violet, gives a bad smell when crushed, due to the evolution of fluorine; the fluorine is supposed to be liberated by radio-active rays, which can indeed produce the deep colour of CaF_2, but they do not give rise to any bad odour. H. B.

335. *Invariability of Radio-Activity in Strong Magnetic Fields.* **A. Piccard and G. Volkart.** (Arch. des Sciences, 3. pp. 543–544, Sept.—

Oct., 1921. Paper read before the Soc. Suisse de Physique.)—Using magnetic fields of the order of 83,000 gauss for a period of 20 to 30 hours, the authors have shown that the rate of decay of ThB is unaffected—any variation produced must be less than 1 part in 1000. A. B. W.

336. *Theory of Scattering of α-Rays through Small Angles.* **W. Bothe.** (Zeits. f. Physik, 4. 2. pp. 300–314, 1921.)—After summarising the earlier work of Rutherford, Geiger, Darwin, and others on this subject, the author develops a theory of small-angle scattering for α-particles of different velocities and for scattering materials of differing atomic weights. The deductions from the theory are compared with the experimental observations of Geiger. A. B. W.

337. *Nomenclature of Radio-Active Series.* **M. C. Neuburger.** (Phys. Zeits. 22. pp. 247–248, April 15, 1921.)—The author analyses radio-active decay products into three types of family, namely: Chief, Trunk, and Branch families. The Chief family of uranium passes through UrII into two Branch families, viz. the radium and the actinium series. Details are given of the order of disintegration of the various series, but reference should be made to the original paper for this information. A. B. W.

338. *Relative Ionisation of α-Particles in Different Gases.* **V. F. Hess** and **M[aria] Hornyak.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 7. pp. 661–672, 1920.)—As Rutherford [Abs. 1001 (1899)] and Bragg [Abs. 839 (1907)] have shown, the number of ions produced in the path of an α-particle varies with different gases. In the investigation now described, the ionisation produced by polonium α-particles has been measured in CO_2, N, H, coal-gas, and oxygen; a comparison being made in each case with the ionisation in air. Taking the ionisation in air as unity, the following relative ionisations have been found experimentally: CO_2, 1·23; N, 0·97; O, 1·12; and coal-gas, 0·88.

A further investigation was made to examine the relative ionisation in these gases at different parts of the range of the α-particle, considerable divergences from the above values being noted. Thus for the last 3 mm. of range of the polonium α-particle the relative ionisations were (taking air = 1): CO_2, 0·92; N, 0·96; O, 1·17; coal-gas, 1·22; and in hydrogen 1·25. Similar relative values are tabulated for other parts of the range. A. B. W.

339. *Range of α-Particles in Relation to Atomic Number.* **H. T. Wolff.** (Phys. Zeits. 22. pp. 352–353, June 15, 1921.)—In a former communication the author showed [see Abs. 1571 (1921)] that the range R of similar α-particles emitted from ThC, RaF, AcX, AcC, and AcC′, is given by the equation: $\log R = \xi \log (\frac{3}{4}M - L + K) + \eta$, a function of the atomic weight M and atomic number (nuclear-charge) N; ξ, η, and K being constants.

The range R is now deduced in terms of the number of electrons, helium nuclei and X_3 particles in the atomic nucleus. Denoting the number of the latter quantity by n_3 and the total number of *all* particles by n, then $R = \eta_1(n - \frac{3}{4}n_3)^{\xi}$. The constants η_1 and ξ have the same value for the three decay-series, with the exception of the beginning of the Ur-Ra family up to Ra. A. B. W.

340. *Distribution of Radium Emanation in Different Phases.* **M[aria] Szeparowicz.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 5. pp. 437–454, 1920. Comm. from the Inst. f. Radiumforschung.)—An investigation is described of the solubility of radium emanation in water and benzol at temperatures between their freezing- and boiling-points. The solubility in, or absorptive power of, benzol is about four times that for water. No peculiarity in solubility is observed in the neighbourhood of the temperature of max. density of water: the solubility continues decreasing as the temperature is raised from 0° C. to 100° C. The solubility coefficients of RaEm in water and benzol at different temperatures have been determined from such observations and have been found to agree with theoretical values deduced by St. Meyer. Interesting observations have also been made which throw some light on the relative solubility of RaEm in the liquid and solid phases of these substances.

Measurements have also been made of the solubility of RaEm in various solutions of metallic salts, etc. The results of such observations are included in a table which should be consulted in the original paper if further details are required. A. B. W.

341. *Dimensions of the α-Particle: Deviations from Coulomb's Law in Close Proximity to Electric Charges.* **A. Smekal.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 5. pp. 455–481, 1920.)—The author deduces mathematically the slight deviation from Coulomb's inverse square law of attraction when the distance apart of the attracting bodies (electrically charged) becomes very small. The case of the α-particle (charged He atom) is taken as an example, the author using Rutherford's value for the dimensions of the nuclear charge, viz. 10^{-13} cm. At a mean distance of $1{\cdot}8 \times 10^{-18}$ cm. he finds the law of force to become $e/r^{2{\cdot}117}$ rather than e/r^2 as required by Coulomb's law. The paper concludes with a discussion of the consequences of such a deviation. A. B. W.

342. *Decay Constant of Actinium and the Branching Ratio of the Actinium Series.* **S. Meyer.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 5. pp. 483–490, 1920. Comm. from the Inst. f. Radiumforschung.)—The author concludes that the half-value period of actinium is about 16½ years, and that the branching ratio of the actinium family from the UrRa families is 4 %. A. B. W.

HEAT.

343. *New Electric Hygrometer.* **J. Cartus.** (Zeits. Vereines deutsch. Ing. 65. pp. 767–768, July 16, 1921.)—The instrument, which is on the market, consists of a number of thermo-couples in series, with alternate junctions in juxtaposition as in a thermopile, one set being covered with muslin which is kept moist with distilled water while the other set is exposed to the air. This arrangement is connected with a galvanometer and acts as a wet-and-dry-bulb hygrometer, the psychrometric difference being indicated by the deflection of the galvanometer. In addition the air temperature is measured by an electric resistance thermometer. The psychrometric difference and the air temperature are actually recorded by the movement of two pointers across a dial on which is engraved a nomogram from which the relative humidity is easily read. The recording portion may be at a distance from the psychrometer, and indeed may serve several, being connected with each at will. For use in cases where the air temperature is not required the instrument has been adapted to read relative humidity directly off a single scale, while an autographic recording device has also been devised. M. A. G.

344. *A Hydrocarbon Flame of very High Temperature.* **E. Hauser** and **E. Rie.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 6. pp. 539–547, 1920.)—In conjunction with J. Kainer and Berthold, Hauser has designed a patented burner, constructed by Koerting, in which an oil is atomised by hydrogen and the divergent cone of oil and hydrogen is surrounded by a shell of oxygen. On porcelain being held in the flame, the carbon is deposited as graphite in the hottest zone and as soot in the shell. This graphite consists of irregular hexagonal scales on the outer surface; the scales are sharp-edged. On the inner (porcelain) side a few transparent highly-refractory crystals are seen which completely burn in oxygen. Sooty carbon from camphor is transformed into graphite when heated in a graphite crucible in the hottest zone; the graphitic character is proved by chemical and microscopical tests. Zircon, chromium, molybdenum, and tungsten can be fused in the flame; the cone temperature is estimated at 3000° C. A Wanner pyrometer only indicated 1700°; but that would be the temperature of the cooler shell. The graphite seems to be formed by vapour condensation. That might explain why Lummer observed fusion of carbon only at a relatively-low current intensity of his arc; at high intensity the re-condensation would be prevented. Charcoal on bricks was partly converted into carborundum by the flame. H. B.

345. *Radiation Pyrometer ("Ardometer") for Measurements from* 1000° *to* 1400° C. **G. Keinath.** (Elekt. Zeits. 42. pp. 1384–1387, Dec. 1, 1921.)—Describes a new form of radiation pyrometer in which an image of the radiator is formed on a blackened plate to which are attached two fine thermo-junction wires. The observer has an eyepiece by means of which he ensures that the plate is more than covered by the image of the radiator, and a galvanometer attached to the thermo-element then gives a measure of the heating effect of the image on the plate, i.e., of the temperature of the radiator. Full deflection is generally reached in about 6 to 8 seconds from exposure to the radiation. The instrument is termed an "ardometer." J. W. T. W.

346. *Determination of the Relative Expansions of Glasses.* **F. E. Wright.** (Optical Soc. of America, J. 5. pp. 453–460, Sept., 1921.)—Describes the polarisation method for studying the relative expansions of two glasses, as, for example, that of a cord embedded in a sample of glass. From the observed change in interference colours the state of radial compression or of radial tension of the included glass can be determined and hence its respectively less or greater coefficient of expansion than that of the enclosing sample. J. W. T. W.

347. *Thermal Expansion of some Refractory Materials at High Temperatures.* **B. Bogitch.** (Comptes Rendus, 173. pp. 1358–1360, Dec. 19, 1921.)—The materials chosen for experiment are those commonly used in the construction of ovens and fire-grates, *e.g.*, silica, clay, and magnesia. Measurements of expansion have been made at temperatures up to about 1500° C. The method consists in heating a brick of the material 9 to 10 cm. long, and 3 to 4 cm.^{2} section, vertically in a small laboratory furnace. A second brick (of fused silica), longer than the one to be tested, is heated side by side with it, and on the top of the shorter brick is another short piece of silica. The total expansion of the specimen at any temperature is then given by expansion of silica ± difference in expansion of the two bricks, expansions being observed by a telescope provided with a micrometer.

The results are exhibited in curves, the materials tested being fused bauxite, clay, chromite, silica, and magnesia, a chemical analysis of each specimen being also given. Fused bauxite gives an expansion of only 9·7 % at 1370° C., while magnesia gives 23 % at 1430° C. In the case of silica there is a point of max. expansion (about 13 %) at 1010° C., and then an actual decrease in length up to 1500° C. T. B.

348. *Ratio of the Specific Heats of Air and of Carbon-Dioxide.* **J. R. Partington.** (Roy. Soc. Proc. 100. pp. 27–49, Oct. 4, 1921.)—Accurate data for a theoretical study of the energy-content of molecules in gases and vapours are urgently required, and the experiments recorded are the beginning of a promised series to include ammonia, SO_2, N_2O, N, etc.

The method adopted in this re-investigation of the ratio of the specific heats, $\gamma = C_p/C_v$, is essentially that of Lummer and Pringsheim. The pressure p_1 and temperature T_1 of the gas under a small excess pressure are measured; the gas is allowed to expand suddenly to (atmospheric) pressure p_2, and its instantaneous temperature T_2 measured. Then $\gamma = (\log p_1 - \log p_2)/\{(\log p_1 - \log p_2) - (\log T_1 - \log T_2)\}$. The special points attended to were (1) a large expansion vessel (130 litres) to eliminate effects of conduction and convection in the gas; (2) a bolometer of very small heat capacity, practically free from lag; (3) a galvanometer (Einthoven "String") of very rapid period to follow in detail the temperature-changes.

The values obtained for γ are then corrected for radiation and for the deviation of the gas from the ideal state. The latter correction was made by means of Berthelot's equation $\left\{p + a/(\mathrm{T}v^2)\right\}(v - b) = \mathrm{RT}$, and amounted to a factor 1·00083 for air at 17° C. and for CO_2, 1·0040. The final corrected results for γ were: Air at 1 atmo. and 17° C., 1·4034 ± 0·0003; CO_2, 1·3022 ± 0·0003. T. B.

349. *Specific Heat and Interatomic Oscillations.* **F. Skaupy.** (Zeits. f. Physik, 4. 1. pp. 100–104, 1921.)—According to Neumann-Kopp the specific heat of solid compounds can be calculated from the sum of the specific heats of the components. This law must hold also, the author argues, for components the specific heat of which is decidedly smaller than the Dulong-Petit rule requires, and this seems to be incompatible with the modern view that the specific heat of solids has its seat essentially in the atom itself [cp. Schrödinger, Abs. 238 (1920)]. The deviation from Dulong-Petit of the specific heat of an element is measured by $\beta\nu/\mathrm{T}$. If an atom contribute to the same extent to the specific heat, whether it be elementary or bound in a compound, and deviate always equally, ν should be independent of the linkage in the compound, and that could not be if the atom were to receive its energy from the surrounding atoms, as has been supposed. The author suggests that the oscillations which determine the energy contents of a solid, are oscillations of the parts of the atom, i.e., of the shell of electrons relatively to the nucleus. The oscillation is characteristic of the forces between these parts, but will be influenced by the neighbouring atoms which excite the vibrations and transfer the energy. On this view, Lindemann's melting-point would be that temperature at which the amplitude of the oscillating shells of electrons becomes commensurable to the mean distance between the atoms. The considerations are extended to gases. Reference is made to similar views of Koref [Abs. 943 (1912)] and of Haber [Abs. 1024 (1920)]. H. B.

350. *Equation of State for Saturated and for Superheated Steam between 30° and 180° C.* **H. v. Steinwehr.** (Zeits. f. Physik, 3. 6. pp. 466–476, 1920.)—The author assumes with Nernst and Levy [Abs. 1717 (1909)] that water-vapour consists of simple and double molecules, both of which obey the gas laws, and explains the discrepancies between steam and ideal gases by suggesting that the equilibrium $(H_2O)_2 = 2\,H_2O$ is displaced by temperature changes. In his calculations Levy further presumed that the heat of dissociation U is independent of the temperature. This latter assumption is untenable. According to recent researches in the Reichsanstalt U is proportional to T^2. So modified the equation of state $pv_r = \mathrm{RT}(1 + \alpha)$, where α indicates the dissociated portion of the gas, agrees better with the experimental data than Levy's. H. B.

351. *The Joule-Thomson Effect for Air.* **F. G. Keyes.** (Am. Chem. Soc., J. 43. pp. 1452–1470, July, 1921.)—Calculations are given of the Joule-Thomson coefficients based on an equation of state previously given by the author. The equation is $p = \mathrm{RT}/(v - \delta) - \mathrm{A}/(v - l)^2$, where $\log \delta = \log \beta - \alpha/v$, δ, A, and l being constants, and the remaining symbols having their usual meaning. An experimental investigation of the Joule-Thomson effect in the case of air by L. G. Hoxton [Abs. 1311 (1919)] gives very high values, and leads to a higher value of the ice-point (273·36) than that arrived at by other methods. The value 273·135 is shown to be substantially correct as deduced from the above equation of state. An explanation of the discrepancies in the observed Joule-Thomson numbers is suggested, which assumes that at the low-pressure side of the plug a temperature drop is superposed on the true Joule-Thomson effect, due to fine gas streams and their subsequent expansion. Corrections are shown to be necessary to the Joly constant-volume specific heats of air to compensate for the increased specific heat of the copper sphere. The corrected values are independent of pressure, thus confirming the validity of the author's equation of state. It is deduced that the constant-volume air-thermometer scale reads directly on the absolute scale, and therefore needs no correction. T. B.

352. *Specific Volume of Liquid Ammonia.* **C. S. Cragoe** and **D. R. Harper.** (Bureau of Standards, Bull. 17. pp. 287–315 [Sci. Papers, No. 420], 1921.)—Specific volumes of pure ammonia under the pressure corresponding to saturation have been determined from − 78° to + 100° C. The method employed is similar to one previously used by Dieterici, and consists essentially in observing, at various temperatures, the volumes of the liquid and vapour phases in equilibrium in a closed vessel. The total mass of ammonia is given by $M = v/\mu + (V - v)/u'$, where u and u' are the specific volumes of liquid and vapour respectively, V the total volume of the vessel, and v the volume of the liquid. Two vessels (pycnometers) were employed of widely different total volumes and filled with unequal masses of ammonia. From the results obtained of the specific vols. of liquid and vapour, a temperature–density curve or " dome " was constructed, from which by extrapolation a critical temperature of 133° C. was deduced. Results are also given in tables and in an empirical equation. T. B.

353. *Generalisation of Reech's Theorem.* **F. Michaud.** (Ann. de Physique, 16. pp. 131–155, Sept.–Oct., 1921.)—Reech's theorem (mechanical effects of heat) has been generalised by Duhem [Abs. 1891 (1906)] as a part of classical thermodynamics. In the present paper the generalisation is attempted from the point of view of general " energetics." The essential factors of energy—" intensity," " extensity "—are explained and illustrated. For the general case of a system of n variable extensities, there will be $n - 1$ equations of the generalised form of Reech's theorem. The theorem is applied mathematically to a number of examples.

The second part of the paper is devoted to the study, on the basis of the previous generalisations, of the criteria of stable and unstable equilibrium. A. B. C. L.

354. *Absolute Entropy and the Chemical Constant.* **M. Planck.** (Ann. d. Physik, 66. 5. pp. 365–372, Jan. 10, 1922.)—In a recent paper [see Abs. 1576 (1921)] on the derivation of dissociation equilibrium from the quantum theory and calculation of chemical constants, Ehrenfest and Trkal have developed a general method for the calculation of the entropy and chemical constants of gases. They criticise the absolute validity of the expression, $S = k \log W$, where W is a definite whole number termed the thermodynamic probability and S the entropy, and opine the dependence of W on the molecular number N as obscure. The present paper is a reply to the above criticism, and deals with the subject both from the general and particular standpoints. Ehrenfest has employed the Boltzmann equation, $S_2 - S_1 = k \log W_2/W_1$, which involves a series of undetermined additive constants, whereas the expression, $S = k \log W_1$, leads to a definite value of the entropy. A further distinction between the expressions is that the latter, on account of the integral character of W_1 possesses zero as the lower limiting value, while Boltzmann's expression would allow the entropy S to possess positive and negative values, so that $S = k \log W_1$ is essentially more special than Boltzmann's expression. These differences are discussed in detail by the author. Ehrenfest's attitude towards absolute entropy is then considered, and his arguments are shown to be impracticable by comparing the ideas of entropy and energy. The explanation of the mode of calculating the entropy S is then discussed at length, the entropy of an ideal monatomic gas possessing N homogeneous atoms being taken as example. For a given total energy in all possible states, the stationary or thermodynamical equilibrium condition is the maximum of W in the statistical sense. In this state the entropy is determined by the energy. If temperature be chosen instead of energy as the independent variable, then a convenient workable expression for the free energy is obtained. The author has assumed the free energy to be a function of the temperature in his argument, although the same result is obtained by taking the entropy as a function of the energy. He then calculates the free energy for a system of N homogeneous gas atoms by the Maxwellian method, and also for a system of many identical models of the N-atomic gas by the Boltzmann-Gibbs method. Both methods lead to correct results. The author claims to have established the validity of the $S = k \log W$ expression. H. H. Ho.

355. *Influence of Pressure on the Explosion Temperature.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr. pp. 220–224, June 20, 1919. Chem. Zentrbl. i. p.146, 1920.)—The explosive contained in a glass tube, open at one end, is placed in a steel cylinder filled with mercury; the cylinder is slowly heated in an oil bath, temperature and pressure being controlled, until explosion occurs. In the experiments with moist glyceryl nitrate the explosion temperature fluctuated somewhat at constant pressure; an increase of pressure of 2500 kg./cm.^{2} lowered the temperature of explosion by 8·4 deg., which was within the limits of experimental error. Dry glyceryl nitrate gave more constant results, but there was no distinct influence of the pressure. Still less was any influence observable in the case of a mixture of tetranitromethane and benzene (2 mols. to 1). When the benzene in the latter instance was replaced by naphthalene, a pressure increase of 2000 kg. raised the temperature of explosion by 5·7 deg. The pressure would influence the thermal conductivity of the material and its environment, as well as the chemical kinetics. H. B.

356. *Thermodynamics and Probability.* **A. Berthoud.** (J. Chim. Phys. 17. pp. 589–624, Dec., 1919.)—Mathematical discussion of the relation between entropy and probability. The second law of thermodynamics, as enounced by Carnot and Clausius, is empirical. Boltzmann and Gibbs put it on a statistical basis, and showed that the entropy is proportional to the log. of the probability; thus the principle of increase of entropy becomes the law of the increase of probability. The author deduces formulæ by means of which it is possible to determine the most probable distribution of the molecules of a gas (monatomic and diatomic) according to their velocity or energy (Maxwell), and also formulæ expressing the entropy of such a gas in terms of its temperature and volume. It is often asserted that the spontaneous separation of the hottest molecules of a gas is connected with a diminution of entropy, in contradiction to the second law; the author proves this assumption to be erroneous. H. B.

357. *Heat of Formation Calculated from the Wave-Lengths of Absorption Bands.* **A. L. Bernoulli.** (Helv. Chim. Acta. 2. pp. 720–728, Dec. 1, 1919.)—The author presumes that the number of planetary electrons of a chemically-reacting atom is the number of its valency electrons. He makes no further assumption as to the structure of the atom, except that the atomic or molecular magnetic field is of the order of 10^9 gauss, as he showed in Verh. deutsch. Phys. Gesell. **1916** (gas friction) [cp. Abs. 1138 (1916)]. As regards the characteristic electronic frequencies of elements, he follows Haber: $m\nu_1^2 = M\nu_2^2$, where the left side refers to atom and the ultra-violet, and the right to the molecule and the infra-red. The latter frequency can be determined from observations of Reststrahlen, from the heat of fusion, thermoelectric force, electric conductivity, solubility, etc. He thus arrives at a formula for the heat of formation of a binary compound containing the atomic and molecular volumes, melting-points, the valency electrons, and the number of charges given up on the formation of the compound. Calculations are made for alkali halides, silver and lead halides, CO_2, CS_2, H_2O, SO_2, SO_3, etc. The agreement is sometimes, but not always, close: AgCl 29·05 (29·0 observed), CO_2 108·3 (106·0). H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

358. *Faraday's "Magnetic Lines" as Quanta.* I. **H. S. Allen.** (Phil. Mag. 42. pp. 523–537, Oct., 1921. Nature, 108. pp. 341–342, Nov. 10, 1921.)—The development of the mathematical conception of Faraday's "magnetic lines" is reviewed in relation to the quantum theory, a generalised statement of which is given. The stationary states of a dynamical system may be determined by Hamiltonian dynamics as applied to conservative systems. The restrictions imposed by the quantum theory require that, when "separation of the variables" can be effected, the mean value of the kinetic energy corresponding to a particular degree of freedom is equal to $\frac{1}{2}nh\nu$, where the mean value is taken over the period $1/\nu$, corresponding to the coordinate under consideration. Identifying this mean energy with the mean electrokinetic energy $\frac{1}{2}Ne\nu$, arising from the periodic motion of an electric charge e with frequency ν, N, the number of magnetic tubes associated with the moving charge, is given by $n(h/e)$. As n is an integer, and e may be identified with the charge of an electron, the simplest interpretation to be given to this result is to assume with Faraday the existence of discrete tubes of magnetic induction, the fundamental or "quantum tube" being determined by h/e, the ratio of Planck's constant h to the electron charge e. This unit tube is equal to $1{\cdot}374 \times 10^{-17}$ E.S.U., or $4{\cdot}120 \times 10^{-7}$ E.M.U. Consequently one C.G.S. magnetic tube (one maxwell) contains $2{\cdot}43 \times 10^{6}$ quantum tubes. The application of this view to the case of circular and elliptic orbits is discussed. A. B. C. L.

359. *Note on the Problem of the Electric Quantum Element; Charges of Ultramicroscopic Particles.* **E. Schmid.** (Zeits. f. Physik, 5. 1. pp. 27–30, 1921.)—This paper is supplementary to the author's previous work [see Akad. Wiss. Wien, Ber. 129. 2A. p. 813, 1920], which was concerned with the Brownian movement of ultramicroscopic selenium particles observed in an Ehrenhaft apparatus. The main object of the former experiments was the comparison of the two methods for size estimation of ultramicroscopic particles, namely, the law of fall and the Brownian movement. In the present paper the electric charges are more thoroughly considered. When the Einstein formula for the Brownian movement, $B = N\lambda^{-2}/2RT$ is combined with the definition equation, $v = P . B$, and applied to the descent of a particle in the gravitational field or to its ascent under an oppositely directed electric field, the following expressions are obtained: $Nmg = 2RTv_f/\lambda^{-2}$, and $Ne = 2RT(v_f + v_s)/\lambda^{-2}E$. The products Nmg and Ne are thus given direct by the determination of λ^{-2}. In the previous work, the comparison of the above two methods was carried out under the assumption of the validity of the Knudsen-Weber law of descent, whereby satisfactory data were obtained, and an average value of $N = 59{\cdot}3 \times 10^{22}$ found from 9200 separate observations. In an analogous manner the value of Ne has now been found, and although Ne appears to be constant, yet two values have been obtained. The one is given using Ehrenhaft's apparatus, while the other results from Fletcher's method. The former value has not yet received an explanation, but the latter is in satisfactory accord with the electrolytic number.

H. H. Ho.

360. *Comparison between the Larmor-Lorentz and the Saha Fundamental Equations for the Ponderomotive Force for Point-Charges.* **A. C. Crehore.** (Phys. Rev. 17. pp. 249–252, Feb., 1921.)—From the form of the expressions for the ponderomotive forces due to Larmor-Lorentz and to Saha for point-charges, the author deduces five points which may each be taken as in favour of the truth of the Saha form in preference to the Larmor-Lorentz form. L. H. W.

361. *Electromagnetic Atomic Model.* **A. C. Crehore.** (Phil. Mag. 42. pp. 569–592, Oct., 1921.)—The author has obtained expressions for the mechanical force between two closed circular rings of uniformly revolving doint-charges, (1) from J. J. Thomson's electromagnetic equations [Abs. 1189 (1915)], (2) from the Larmor-Lorentz equations [see preceding Abs.]. In both cases the force between two neutral atoms comes out exactly zero at great distances. In the present paper the same calculation is made on the basis of Saha's theory [Abs. 1217 (1918) and 385 (1919)], which gives a non-zero result, which is interesting. From Saha's pair of three-dimensional equations for the forces between two point-charges, each moving in the most general form of path, the author obtains a single equation expressed in his own notation. The investigation comprises three stages (1) to express the instantaneous force upon one element of the first ring due to one element of the second ring in terms of the circular motion; (2) to integrate these forces around each ring; (3) to average the force for all orientations of the axes of the rings on the assumption that all directions are equally probable. In (1) the complete equations are developed, and then simplified by the restriction to those terms only in the final result which at great distances vary inversely as the square of the distance, but which hold for all orders of β_1 and β_2, the ratios of the velocity of the point to that of light. It is noteworthy that while the equations derived from the Larmor-Lorentz equations contain terms of the order of the reciprocal of the distance, which are difficult of physical interpretation, no terms of order lower than the inverse square occur in the equations here obtained. In (2) the analysis is given for the derivation of one only of the twelve definite integrals required, the results only being given for the remainder, as the procedure is of the same type for all. The value of the instantaneous force is found to be independent of the time, but dependent upon the relative positions of the orbits. The final expression for $\overline{F}$, the average force, upon the first ring due to the second ring for all orientations is, to the order of terms in β^4,

$$\overline{F} = E_1E_2/kr^2(-1 + \tfrac{2}{3}\beta_2^2 - \tfrac{1}{2}\beta_1^2 + \tfrac{3}{20}\beta_2^4 + \tfrac{1}{3}\beta_1^2\beta_2^2 - \tfrac{3}{8}\beta_1^4 \ldots), \quad \text{(A)}$$

where E_1 and E_2 are the complete charges of the respective rings and k is the specific inductive capacity. The corresponding value, according to the Larmor-Lorentz theory, is—

$$\overline{F} = -E_1E_2/kr^2(1 + \tfrac{2}{3}\beta_2^4 + \tfrac{4}{5}\beta_2^6 + \tfrac{6}{7}\beta_2^8 \ldots) \ldots \text{(B)} \quad \text{[Abs. 1082 (1919)].}$$

Consider the force upon a first moving point-charge due to a second charge at rest. The Larmor-Lorentz instantaneous force reduces to the electrostatic force, which means that it is immaterial whether the first electron be in motion or not. The Saha instantaneous force depends on the state of motion of the first charge, which appears to the author the more rational. Again, at great distances the Larmor-Lorentz theory gives a force varying as the reciprocal of the distance, a law of force unknown to experience. The Saha theory gives a force varying as the inverse square. The author concludes that the former theory does not give the true force, while the latter may do so. Between two neutral bodies composed of atoms, each having charges in rotation with an equal number of stationary charges of opposite sign, the force is zero according to (B). According to (A) it is $F = \Sigma(E_1\beta_1^2)\Sigma(E_2\beta_2^2)/3kr^2$ . . . (A_1); and the force between two neutral atoms before averaging for all orientations is $F = (Y^2+\xi^2)\Sigma(E_1\beta_1^2)\Sigma(E_2\beta_2^2)/2kr^2$ . . . (A_2), where $(\gamma^2+\xi^2)r^2$ is the square of the perpendicular distance from the centre of the first atom to the axis of the second. The two axes now having fixed directions, the force therefore varies from zero, when the axis of the second atom is directed towards the first atom, to a maximum, when the first atom is in the equator of the second atom, but always attractive and obeying the inverse square law. A_1 and A_2 express very completely the general features of the gravitation law $F = k^1M_1M_2r^{-2}$, with which A_1 becomes identical if $M = \Sigma(E\beta^2)/(3kk^1)^{1/2}$. A_1 implies Newton's third law. The author shows also that if it may be assumed that the atoms in a crystal are divisible into four equal groups, each group having axes parallel respectively to the four median lines of a regular tetrahedron, as the author has shown to be probable [Abs. 1189, 1534 (1915)], then the attraction between crystals will be the same as for other matter, which is in accordance with experience. On the Saha theory, however, there is no possibility of an equilibrium velocity for a ring of electrons. But the author points out that this does not involve the repudiation of Bohr's theory in its present generalised form, and that strict adherence to the Bohr model renders the representation of phenomena in terms of electromagnetic theory difficult, if not impossible. The Lorentz electron is pictured as a sphere when not in translational motion with electromagnetic energy $W=3mc^2/4$, neglecting the state of internal motion of the charge. But the equilibrium will necessarily be unstable according to electromagnetic theory, and Einstein and others have considered that $W = mc^2$ is the true equation, the extra $mc^2/4$ being due to the normal state of internal motion of the nucleus. It appears, then, that the electrical charge at rest is a pure fiction, having no existence anywhere. The author then replaces the assumed surface pressure maintaining the stability of the electron by the mathematically equivalent conception of a surface tension, and calculates the shape of the oblate spheroid rotating at a speed such that the work done against the tension in increasing the area is $mc^2/4$. A rigorous solution being at present unattainable, he assumes provisionally that since the electrons in the atom are not to revolve in rings, and since the nucleus is the main body contributing to the mass of the atom, it is a rotating body of charge, and may be replaced so far as great distances are concerned, by an equivalent continuous ring of charge in rotation. The frequency of revolution of the single electron in the Bohr H-atom is twice the Rydberg constant, and he assumes that this now represents the frequency of revolution of the ring equivalent to the nucleus. The H-atom will then be represented by a very small oblate spheroid C, the nucleus, with two immensely larger spheroids A and B, on each side of it, the three having a common polar axis PQ. The *effective* nucleus consists of two charges—the nucleus C (having a positive charge $2e$) and one negative electron, A or B, of single charge e, which are inseparable, making the effective nuclear charge $+ e$. Thus from the neutral atom only one electron is detachable. Both electrons in the normal state are in contact with the charge C, one at each pole. All three rotate about PQ, but the electron has no tendency to describe an orbit around the nucleus. On the basis of this model, gravitation is accounted for quantitatively as well as qualitatively to a remarkable degree of accuracy, the equatorial diameter of the nucleus being $7 \cdot 054 \times 10^{-16}$ cm., calculated electromagnetically; and $6 \cdot 4 \times 10^{-16}$, calculated from Newton's law.

G. W. DE T.

362. *Electrostatics of a Uniform Gravitational Field.* **E. Fermi.** (N. Cimento, 22. pp. 176–188, Sept.–Oct., 1921.)—Deduces equations

$$\Delta^2\phi + \frac{G}{c^2}\frac{\partial\phi}{\partial z} = -c\left(1 - \frac{G}{c^2}z\right)\rho. \quad \phi = \frac{ce}{4\pi}\left(\frac{1}{r} - \frac{G}{c^2}\frac{z}{r}\right),$$

analogous to Poisson's and Coulomb's equations respectively, G being the acceleration of gravity, and e an electric quantity concentrated at the origin of coordinates. The electric part of the electromagnetic field generated by a fixed electric charge in a uniform gravitational field of intensity G is equal to the electric part of the electromagnetic field which the same charge would produce in the essence (? absence) of the gravitational field if it moved with an acceleration G/2 in a sense opposed to the gravitational field. The superficial density on a sphere is $\sigma = (e/4\pi R^2)(1 + 2G/c^2 \ . \cos\theta)$; and in the gravitational field a sphere is polarised with a moment equal to $(2G/3c^2)eR^2$. An electromagnetic quantity has weight equal to that of a material mass U/c^2, where U is the electrostatic energy of the system. The origin of coordinates has the properties of a centre of gravity. A. D.

363. *Dynamics of a Rigid System Electric Charges in Translatory Motion.* **E. Fermi.** (N. Cimento, 22. pp. 199–207, Sept.–Oct., 1921.) —The electromagnetic field produced by the motion causes mutual forces between the component charges, the resultant of which does not vanish. This is worked out mathematically, with extensions to any system and any velocity. Electromagnetic quantities have not only a scalar, but also a vector mass. The equations of electronic dynamics are confirmed.

A. D.

364. *Measurements of the Deformation of the Earth's Electric Field by Aircraft.* **W. Müller.** (Ann. d. Physik, 63. 7. pp. 585–620, Dec. 1, 1920.)—Measurements of the potential gradient in the free air may need correction on account of the disturbance of the actual field by the aircraft carrying the instruments. It was in order to determine the reduction factor, or number by which to multiply the observed to obtain the true gradient, for some high-level observations by Everling in a free balloon, that the present work was undertaken. By the principle of electrical similarity results for the large-scale case may be inferred from laboratory experiments, and this was the method adopted. A model was introduced into an artificial field maintained between two parallel plates and the disturbed field was mapped out by means of a drop-collector. The experimental methods and sources of error, both in apparatus and method, are fully dealt with. Everling's observations, when reduced, show a value of the potential gradient in the neighbourhood of the 9-km. level of about 4 volts/m. Besides free balloons, experiments were made with models of airships, aeroplanes, and kite-balloons, and the fields surrounding them are represented in diagrammatic form. The validity of the method was tested by observations during an actual free-balloon flight. M. A. G.

DISCHARGE AND OSCILLATIONS.

365. *Passivity and Photo-Electricity.* **W. Frese.** (Zeits. wiss. Phot. 21. pp. 37–44, July, 1921.)—Making use of iron and other metals, the author has repeated and extended the experiments of Allen [Abs. 850 (1913)], who found that active iron is strongly photo-electrically sensitive to light, but passive iron less so. Irregular results at first obtained indicated the necessity of using metals with absolutely clean surfaces and chemicals in a high state of purity; in particular the water and alcohol must not depress the sensitiveness of platinum when allowed to dry on this metal.

It is found that the photoelectric sensitiveness of Fe, Zn, and Al is considerably depressed by treatment with alcohol or water and subsequent drying. With Cu, Co, Ni, Ag, Au, Pd, and Pt, any such effect exists at most in very slight degree. All oxidising agents which render Fe, Ni, and Co passive greatly diminish the photoelectric sensitiveness, whereas reducing agents, especially nascent hydrogen, enhance it; such effects become more intense as the period of action of the reagent is prolonged. Exactly similar phenomena are observed with Pt and Pd, which cannot be rendered passive, so that Allen's hypothesis concerning the parallelism between passivity or activity and photoelectric sensitiveness is inaccurate. Further, with Au, Ag, Zn, and Al, the photoelectric sensitiveness is more or less strongly depressed by oxidising agents and greatly augmented by reducing agents, particularly by nascent hydrogen. When, however, the metals are used as anodes and undergo oxidation, the relations are more involved.

The reduction of the photoelectric sensitiveness of Fe, Al, and Zn by treatment with alcohol or water is to be attributed to the occurrence of slight oxidation. The marked increase in the photoelectric sensitiveness caused by hydrogen is explained by the hypothesis, which has been advanced, that hydrogen is the principal carrier of photoelectric sensitiveness. T. H. P.

366. *Excitation and Ionisation Potentials of Mercury.* **E. Einsporn.** (Zeits. f. Physik, 5. 4. pp. 208–219, 1921.)—This paper extends and completes the results obtained by Franck and Einsporn [Abs. 126 (1921)]. The excitation potential of the Hg resonance line $\lambda 2536\cdot 7$ was found to be $4\cdot 9$ volts, and that of the line $\lambda 1849$ to be $6\cdot 7$ volts. Using the resonance potentials of $4\cdot 9$ and $6\cdot 7$ volts as standard points the ionisation potential was determined as accurately as possible. A value was obtained of $10\cdot 38 \pm 0\cdot 05$ volts, from which the quantum h is found to be $(6\cdot 593 \pm 0\cdot 064) \times 10^{-27}$ erg. sec. A. W.

367. *Convection Phenomena in Ionised Gases.* **V. F. Hess.** (Akad. Wiss. Wien, Ber. 129. 2A. No. 6. pp. 565–608, 1920. Comm. from the Inst. Radiumforschung.)—The paper describes an investigation of the effects of ion-wind in various gases. The wind-pressure of the ion-wind has been determined under varying conditions of current density, ion velocity, etc., and in various gases; *e.g.*, air, CO_2, H_2, O_2, N, coal-gas, water-vapour, and chloroform vapour. It was found that in all cases the pressure of the ion-wind was greater in the case of positive ions than for negative ions. An investigation of the pressure of the "wind" at different gas pressures showed that the mean ion-velocity was not exactly proportional to the reciprocal of the gas pressure; thus from 750 mm. to 600 mm. it increases *more* rapidly. A. B. W.

368. *Neutrons in a Discharge Tube?* **J. L. Glasson.** (Phil. Mag. 42. pp. 596–600, Oct., 1921.)—The possibility of the existence of a substance of zero nuclear charge was first mooted by Rutherford in the Bakerian Lecture for 1920 [Abs. 1227 (1920)]. The existence of such a particle seems a logical extension of present-day views of nuclear structure.

In a search for such particles the most likely place for their existence appears to be amongst the positive rays in a hydrogen discharge tube, since there is in such a tube a plentiful supply both of free hydrogen nuclei and of electrons. If the hydrogen nucleus in its passage through the residual gas acquired a neutralising electron the neutron would, owing to the much greater momentum of its positive nucleus, continue its course with practically unchanged velocity, just as the ordinary natural hydrogen atoms have been shown to do by J. J. Thomson.

The author describes an experimental procedure for producing and detecting such neutrons, if they exist, but under all the experimental conditions as yet examined has failed to detect the existence of particles of the nature indicated. A. B. W.

369. *Rotation of Electric Discharge in a Magnetic Field.* **C. E. Guye** and **A. Rothen.** (Arch. des Sciences, 3. pp. 441–470, Sept.–Oct., 1921.)—A summary of previous work is given, noting that of Henger (unpublished) who found that the velocity of rotation depends on difference of potential between the electrodes, the intensity of the discharge current, the intensity of the magnetic field, the nature and pressure of the gas, and the material and form of the electrodes. Preliminary experiments by the authors confirm these results.

The discharge tube used is a vertical cylinder of metal (to avoid electrostatic charges on the walls) closed at one end by a glass window. A second cylinder is placed inside supporting a ring which forms a peripheral electrode. The central electrode is a disc in the plane of the ring, the discharge taking place between the edge of the disc and the ring. Both electrodes are gilded, otherwise the discharge covers them with a non-conducting layer which destroys the regularity of the discharge. The rotation of the discharge depends upon the purity of the gas, and particular care is taken in the purification of the gases used, namely nitrogen, oxygen, argon, CO_2, and hydrogen. (H gave no regular rotation under the conditions of these experiments.) The magnetic fied is produced by a coil surrounding the tube.

The central disc is used either as anode or kathode. When it acts as kathode in nitrogen, under appropriate conditions, the discharge is found to rotate spontaneously without the magnetic field, which may be used to start to rotation in either direction. No spontaneous rotation is found when the central disc is the anode. The effects of variations of gas pressure, current intensity, magnetic field intensity, and diameter of the electrodes on the velocity of rotation of the discharge are studied. For a discharge current of less than 1 milliamp. and for pressures between 1 cm. and 15 cm. of Hg it is shown that (1) with constant gas pressure (for gases not showing spontaneous rotation) the velocity of rotation created by the magnetic field is proportional to the field; (2) under conditions which produce spontaneous rotation, it is the *increase* of velocity engendered by the magnetic field which is approximately proportional to the field; (3) with constant magnetic field in the absence of spontaneous rotation (or minus that velocity when it exists) the velocity of rotation is inversely proportional to the pressure; (4) the velocity is a function of the intensity of the discharge current, increasing as the current increases. A simple kinetic theory is given of the motion of an ion under mutually perpendicular electric and magnetic fields and undergoing molecular collisions. For a positive ion $V = eH/(12\pi\sigma^2 Nm)$, where V is the resulting mean velocity of the ion in a direction perpendicular to the fields, e the charge on the ion of mass m, H the intensity of the magnetic field, σ the sum of the radii of the ion and molecule, and N the number of molecules per unit volume. The theory assumes uniform fields, which condition is not fulfilled in practice, but it gives velocities of the right order especially when the discharge current is small and inequalities of the distribution of electricity along the discharge are not so accentuated.

The spontaneous rotation is produced with regularity only in pure nitrogen, but is observed in mixtures of N and O. It occurs between narrow limits of pressure; a max. velocity is observed at a pressure of 9 cm. of Hg. This max. velocity is equal to one which normally would be set up by a magnetic field of 150 gauss. T. H.

370. *Measurement of Transmission Speed of Electric Waves in Wires.* **Mercier.** (Comptes Rendus, 173. pp. 768–769, Nov. 2, 1921.)—Short stationary electric waves were obtained by Gutton and Touly's method [Abs. 476 (1919)], and the positions of the loops determined by means of a sliding bridge and detector lamp, the steady current of which was measured by a micro-ammeter, and plotting the resonance curves as functions of the bridge displacements. An accuracy to 0·1 mm., at least, was obtainable. The equidistance of the loops being thus verified, the wave-length measurements could be made between two nodes including a train of waves, making a length of several metres to be measured, so reducing the error to less than 1 in 100,000. The period was then measured by Abraham and Bloch's method [Abs. 878B (1919)], using an oscillator the frequency of which could be measured directly by a clock and had a numerous series of harmonics. The beats of one of these with the fundamental note from an independent source itself having numerous harmonics were then observed, and the process could be repeated successively a number of times. In this way the range of observations was extended from waves of period comparable with a second down to waves of the order of a metre in length (of frequency 300,000,000). With quite simple precautions the comparison of frequencies could be made with an error of not more than 1 in 100,000. Over the whole range of these preliminary experiments the author estimates that the error in the rate of propagation deduced from them did not exceed 1 in 10,000. G. W. DE T.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

371. *Influence of Lack of Homogeneity upon the Determination of Thermoelectric Constants.* **G. Borelius.** (Ann. d. Physik, 66. 1. pp. 73–80, Oct. 27, 1921.)—The values of the thermoelectric power and the Thomson coefficient may be deduced from a knowledge of the variation of the thermo e.m.f. of a couple with temperature according to the well-known theory. Large temperature differences of the junctions produce lack of homogeneity in the wires, and the constants deduced in this manner may suffer serious errors. The magnitude of these errors is obtained theoretically in the paper, and it is shown that as regards the thermoelectric power the error diminishes the nearer the junction temperatures approach each another, but as regards the Thomson coefficient, a large temperature gradient in the wire diminishes the error in the value deduced for this constant. The Peltier coefficient should be measured directly, and the thermoelectric power obtained from this. L. L.

372. *Time-Changes of the Pressure within an Insulating Liquid in an Electrostatic Field.* **L. Bouchet.** (Comptes Rendus, 173. pp. 914–916, Nov. 14, 1921.)—The author experiments with a rectangular trough two walls of which form the armatures of a condenser; the other walls are of glass, and gum lac is used for cementing the parts. There is a hole in the bottom communicating with a capillary tube. When the field (3000 to 6000 volts/cm.) is turned on, the liquid rises on the armatures and falls in the capillary. Observing the level-changes during the first 60 seconds there is first a rise in the case of xylene, hexane, and oil of vaseline, and a fall for benzene, limonene, and terebinth essence. The variations amount mostly only to a few per cent., but attain 25 % in the case of oil of vaseline. The pressure changes may be due to conductivity changes. With alternating currents the pressures become quite steady within 5 seconds. These fluctuations would affect determinations of the specific inductive capacity. [See next Abs.] H. B.

373. *Action of an Electric Field on an Insulating Liquid.* **F. Michaud** and **A. Balloul.** (Comptes Rendus, 173. pp. 1165–1167, Dec. 5, 1921.)—Referring to Bouchet [see preceding Abs.] the authors point out that they have in similar experiments made use of a vertical cylinder provided with a lateral tube in which, however, the liquid was never in contact with any mastic. This apparatus is more easily mounted and cleaned, and working with pure liquids, they have never observed any of the irregular fluctuations of Bouchet. Such irregularities appear in the case of impure and of viscous liquids like vaseline oil, as was foreseen. Benzene free of thiophene gave values constant within 1/700. The slightest trace of conductivity would affect the surface and annul the electric field. Impure liquids would give rise to electrolysis and to level-changes, the sense of which cannot be predicted; these electrolytic effects would tend to vanish when alternating fields are used, as Bouchet also observed. The comparison of Bouchet's values for the specific inductive capacity with the values of others is difficult because

Bouchet's temperatures are rather high, 27° to 30°; but his benzene value seems too high. H. B.

374. *Photoelectric Conductivity of Zinc Blende.* **B. Gudden** and **R. Pohl.** (Zeits. f. Physik, 5. 2 and 3. pp. 176–181, 1921.)—The photoelectric conductivity of zinc blende was further investigated [see Abs. 502 and 915 (1921)], and was traced to the absorption of light by the sulphide itself, while the conductivity is diminished by the light absorption of small impurities, just as in the case of the diamond. As regards the spectral distribution, it is of little importance whether the exciting light is parallel or perpendicular to the direction of the lines of the electric field. For investigating the selective photoelectric conductivity only high electric fields were employed when the crystal was used in powdered form, since the effect of the surfaces of separation between the individual crystal fragments tends towards the disappearance of the maximum with small values of the field. A. W.

375. *Contact Electricity in High Vacua.* **A. Coehn** and **A. Lotz.** (Zeits. f. Physik, 5. 4. pp. 242–263, 1921.)—For this investigation the evacuated vessel was made of one of the substances in question; the other was usually in powdered form and could be brought in contact with the inner wall of the vessel by tilting it. A variety of crystalline substances were used in powder form, and the results obtained with these are presented in tabular form. A number of metals were also used, and a table is given showing the nature of the charge developed when these are brought in contact with glass. [See Abs. 145 (1910) and 1465 (1920).] A. W.

376. *Mutual Inductance between Two Equal Circles in Parallel Planes.* **E. Mathy.** (J. de Physique et le Radium, 2. pp. 355–358, Nov., 1921.)—If r be the radius of each circle, d the distance between the planes, c the distance between the centre of a circle and the foot of the perpendicular let fall on its plane from the centre of the other circle, M the mutual inductance between them, then

$$M = \frac{4\pi r}{c+r}\left\{d^2 + (c+2r)^2\right\}^{\frac{1}{2}}\left[\frac{d^2 + r^2 + (c+r)^2}{d^2 + (c+2r)^2}\mathrm{K} - \mathrm{E}]\right],$$

where $\mathrm{K} = \int_0^{\frac{\pi}{2}} \frac{\partial\phi}{(1 - k^2\sin^2\phi)^{\frac{1}{2}}}$, $\mathrm{E} = \int_0^{\frac{\pi}{2}} (1 - k^2\sin^2\phi)^{\frac{1}{2}}\partial\phi$

and $k^2 = \dfrac{4r(c+r)}{d^2 + (c+2r)^2}$

Substituting the expansions for K and E, we get

$$M = \tfrac{1}{4}\pi^2 k^3 \sqrt{r(c+r)}\left(1 + \tfrac{3}{4}k^2 + \frac{75}{128}k^4 + \frac{245}{512}k^6 + \ldots\right)$$

If we put $c = 0$, these formulæ become the same as those given in Abs. 1946 (1921). A. R.

377. *Effective Self-Capacity, Inductance, and Resistance of Coils.* **G. W. O. Howe.** (Inst. El. Eng., J. 60. pp. 67–72, Dec., 1921.)—

Various attempts have been made to calculate the natural frequency of a coil from its dimensions, and to find some mathematical explanation of the fact that the self-capacity is independent of the wave-length. In the present paper an outline is given of a method of treating this problem which appears to be an improvement on any previously published, both as regards the assumptions made and the simplicity of the treatment. It is shown that the effective self-capacity depends only on the radius and on the shape of the coil, and is independent of the frequency. In arriving at this result, the effect of dielectrics other than air is neglected, and the assumption is made that the current has a sine-wave distribution along the coil. A closer approximation may be made by assuming that the current distribution may be analysed into a fundamental and a third harmonic. A. W.

378. *Sensitive Method of Determining the Frequency and Amplitude of High-Frequency Oscillations.* **J. J. Dowling** and **J. J. McHenry.** (Electrician, 87. p. 675, Nov. 25, 1921.)—The arrangement used is similar to one previously described [Abs. 719 (1921)]. Suppose the anode current has a value I and the "zero-shunt" resistance is adjusted so that there is no current through the galvanometer G. If I increase by a certain amount i, then a current $Ri/(R + g)$ will flow through G, g being the galvanometer resistance. With a sensitive galvanometer the deflections may be regarded as proportional to the alternating p.d. set up across the condenser C of a wave-meter circuit connected to the grid and filament. If L (the inductance of the wave-meter circuit) is constant, the galvanometer maximum is proportional to the frequency, and the maximum is inversely proportional to the frequency when C is constant. This has to be taken into account in comparing the amplitudes of oscillations of different frequencies in a circuit at a fixed distance from the wave-meter. Subject to this consideration, the max. galvanometer deflection, besides indicating the resonance point, also measures the strength of the oscillation. The arrangement indicates when the coupling between the wave-meter and the circuit under test is too close. If this is the case a double maximum is obtained. This disappears when the coupling is loosened. A. W.

379. *Valve Method of Finding Dielectric Coefficient of a Liquid.* **R. Whiddington.** (Cambridge Phil. Soc., Proc. 20. pp. 445–446, Nov., 1921.)—Two oscillatory circuits are loosely coupled and their tuning is adjusted until suitable beats are obtained in the anode circuit of one of them. These beats are detected by utilising condensers, a potentiometer, and an aperiodic galvanometer suitably connected. By altering the dielectric of the condenser across the oscillatory circuit the beat rate changes. The known condenser variation required to restore the original beat rate enables the dielectric coefficient to be computed. N. W. M.

380. *Silicon Carbide Detectors.* **E. Luchsinger.** (Phys. Zeits. 22. pp. 487–491, Sept. 1, 1921.)—An investigation was made of the operation of a silicon carbide–steel detector under varied conditions. The results show that no trace of electrolytic action can be observed. The rectification obtained is not lessened either at low or high temperatures, remaining constant even when the crystal was in a glowing condition. From this it would appear that, for this detector at any rate, no explanation of its action can be based on electrolytic effects due to the presence of a layer of moisture on the surface of the crystal. A. W.

381. *Unipolar Conductivity.* **G. Hoffmann.** (Phys. Zeits. 22. pp. 422-424, Aug. 1, 1921.)—A continuation of previous work [Abs. 1922 (1921)]. The present paper discusses the results previously obtained with special reference to the one-sided character of the conductivity between plates of different metals situated very close together and subjected to intense fields. [See Abs. 1321 and 1322 (1920).] A. W.

382. *Kathode-Ray Oscillograph.* **M. Brenzinger.** (Phys. Zeits. 22. pp. 491–495, Sept. 1, 1921.)—If an influence machine is used for a Braun kathode-ray tube, difficulties arise owing to various causes, the chief objection being the lack of constancy of the voltage obtained. These difficulties can be overcome by the employment of rectified high-voltage alternating current. The arrangement here described for this purpose consists of a high-voltage transformer, the secondary of which is in series with a rectifying valve and condensers C_1, C_2 in parallel. The filament of the valve is heated by means of a step-down transformer from the main a.c. supply. The terminals of the condenser C_2 are connected to the Braun tube, and a high ohmic resistance in series with C_2 prevents too big a current from flowing. Various methods of obtaining oscillograms are discussed. That adopted by the author makes use of an auxiliary current rising practically linearly to a maximum, then dropping to zero, then rising again, and so on. This current passes through a deviation coil which deflects the kathode rays. The period of the interruptions is made to coincide with that of the oscillations under investigation and hence stationary curves are obtained, examples of which are reproduced. The auxiliary current is obtained from a circuit of very low resistance and large inductance provided with a motor-driven contact breaker, across which is shunted a condenser in parallel with a large ohmic resistance. A. W.

ALTERNATING CURRENTS AND MAGNETISM.

383. *A Theory of Paramagnetism.* **P. Dejean.** (Comptes Rendus, 173. pp. 770–771, Nov. 2, 1921.)—The author has elsewhere described experiments showing that the apparent magnetic susceptibility of a soft steel bar for which length/diameter $= m$ is very small behaves very like a paramagnetic body in that it remains constant in an increasing magnetic field up to a strength which increases as m decreases. The rate of increase in the magnetic intensity as the field is increased consequently decreases towards the limiting saturation value of the metal. Throughout the region of constancy the constant value decreases, and vanishes, with m. A value of m for which the susceptibility is of the order of paramagnetic bodies, 10^{-4} to 10^{-5}, is therefore obtainable. Moreover, Shuddemagen has shown [Abs. 1916 (1907)] that, given m, the demagnetising field increases as the diameter decreases. The increase in passing from diameter of 6 mm. to 3 mm. is quite noticeable, so that it may be expected to become of importance in the case of magnetised particles of atomic dimensions. This might well give susceptibility of paramagnetic order to elementary magnets even in case of m being greater than in these experiments. Further, the author has found that when a series of magnetic elements are arranged in a line with an approximately fixed interval between each in a strong demagnetising field, and the interval is increased, when it is from once to twice the length of the elements, the mutual interactions of the elements become insensible. It seems conceivable, then, that a paramagnetic body might be of analogous constitution. This would explain the foregoing experimental results, and the effect of further increasing the intervals causes variation in the susceptibility represented by similar curves to those obtained experimentally by Curie for the change, by simple heating, from the ferromagnetic to the diamagnetic state. Moreover, the rise of temperature that might be expected, either directly or in consequence of the gradual formation of an allotropic isomorphic variety of the metal, might well suffice to bring about the requisite increased separation, and P. Weiss's experiments on pyrrhotine and his discovery in the magnetic plane of a direction of easy magnetisation tend to support the view that such strings of elementary magnets do exist in ferromagnetic bodies. The suddenness of the passage from the ferromagnetic to the paramagnetic state, shown by the curves, would account for the passage from one state to the other being so infrequently observed. The hypothesis here suggested, moreover, accounts very simply, and purely magnetically, for the strengths of molecular magnetic fields, while Coulomb's law does not.

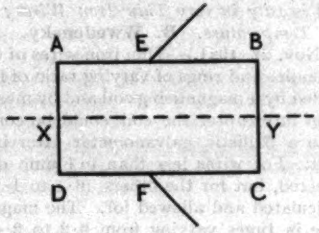
[Errata, *ibid.*, p. 956, Nov. 14, 1921.] G. W. DE T.

384. *Magnetic Viscosity in very Thin Iron Wires; Dependence upon Magnetisation and Temperature.* **B. Wwedensky.** (Ann. d. Physik, 66. 2. pp. 110–129, Nov. 22, 1921.)—Thin iron wires of different diameters were formed into bundles and rings of varying ratio of length to diameter. These were surrounded by a magnetising coil and by means of a Helmholtz-Edelmann pendulum interrupter the coil could be connected at definite intervals of time to a ballistic galvanometer after interruption of the magnetising current. For wires less than 0·1 mm. diam. eddy-current effects can be neglected, but for the others (0·1 to 1·74 mm.) the eddy-current effect is calculated and allowed for. The magnetisation is found to fall to half-value in times varying from 0·2 to $2{\cdot}4 \times 10^{-6}$ sec. and to one-tenth in about 0·5 to $4{\cdot}0 \times 10^{-6}$ sec. Thus there is a true magnetic viscosity. Experiments were also made in which the rings were subjected to a constantly-maintained transverse magnetic field, being placed between the pole-pieces of a large electromagnet. These transverse fields could be varied up to 235 c.g.s. units. The time of fall of the magnetisation to a definite fraction increased at first with the magnitude of the transverse field, attained a maximum and then diminished. The effect of temperature on the time of fall was also investigated, the max. time of fall being attained near the Curie point and then diminishing. The author is led to the conclusion that the time of fall depends primarily on the change of magnetisation. There is no essential difference between the behaviour of bundles and rings. L. L.

385. *Magnetic Shielding in Ballistic Standard Coils.* **H. Greinacher.** (Zeits. Instrumentenk. 41. pp. 240–241, Aug., 1921.)—When the solenoid, employed to standardise a ballistic galvanometer, contains a secondary wound on a metal tube which fits over the primary, the arrangement is, in principle, a transformer with two secondaries, the second of which is formed by the metal tube in which currents are also induced. There is consequently a shielding action, and the value of dN/dt for the secondary coil is diminished by the presence of the metal tube. The end result, however, is the same, provided that the time-lag introduced is small compared with the period of the galvanometer. G. E. A.

386. *Path of Small Permeable Body in Magnetic Field.* **W. Cramp.** (El. Rev. 89. pp. 736–737, Dec. 2, 1921.)—A comparison is made between the case of a small polarised particle within the field due to a single centre of force of opposite sign, and that of a permeable particle placed in the same field. In the former case, the surfaces of equal potential energy are spheres drawn round the centre of force, and the energy varies inversely as the radius. In the latter case, assuming constant permeability, the equipotential surfaces are also spheres, but the energy per unit volume is $\mu H^2/8\pi$, and H is m/r^2 at distance r from a pole m. Hence the energy per unit volume varies inversely as r^4, and the force inversely as r^5. By superposition, the lines of force and of equipotential are found for the polarised and permeable particles when near a pair of centres of like and of unlike force. Reference is made to the work of Hartog and Belas [Abs. 593 (1916)], two of whose drawings are reproduced. G. E. A.

387. *Axial Thermomagnetic Effect in Bismuth Analogous to the Axial Galvanomagnetic Effect.* **A. Sellerio.** (Comptes Rendus, 173. pp. 974–976,



Nov. 21, 1921.)—A plate of bismuth ABCD (24 mm. × 17 mm. and 0·37 mm. thick) is traversed by a flux of heat parallel to AB (AD, 96° C.; BC, 32° C.). Two thin copper wires soldered to the middle points of AB and CD are connected to a sensitive galvanometer (1 scale div. = 25×10^{-9} volt). When placed in a magnetic field of 4000 c.g.s. units with the lines of force parallel to EF the change in the deflection of the galvanometer is 108 scale divs. and on reversal of the field 128 scale divs. When the plate is oriented the effect diminishes, and vanishes when XY makes 15°. This angle, with the direction of the field, remains sensibly the same with variation of the heat flux, although the magnitude of the effect changes. This axial effect can be contrasted with the transverse thermomagnetic effect of Ettingshausen and Nernst, which would be obtained by rotating the plate through 90° about XY, just as the axial galvanomagnetic effect previously described [Abs. 937 (1921)] may be contrasted with the Hall-effect. Perturbations of the effect which do not change sign with reversal of the field also exist. L. L.

388. *Analogies and Differences between the Galvanomagnetic and Thermomagnetic Effects.* **A. Sellerio.** (Comptes Rendus, 173. pp. 1352–1355, Dec. 19, 1921.)—In this paper data are given of measurements on the effect described in the preceding Abstract. The axial thermomagnetic effect when plotted against the orientation of the axis XY, is found to follow a sine law, becoming zero for $\phi = 15°$. The perturbation follows a law which is similar but of double the periodicity. This is the same for the galvanomagnetic effect observed in this plate. There is, however, a dissimilarity in the two effects. The perturbations of the galvanomagnetic effect, plotted for the two directions of the field and for various orientations, are asymmetrical, whereas the thermomagnetic perturbations are symmetrical. L. L.

389. *Demagnetising Field of Cylindrical Bars of Mild Steel.* **Dejean.** (Comptes Rendus, 173. pp. 650–652, Oct. 17, 1921.)—The author gives the results of tests, by the ballistic method of reversals, of eight cylindrical bars, all 20 mm. in diameter, and respectively 5, 10, 20, 50, 100, 200, 400, 1200 mm. long, and a ring, all forged from the same ingot of extra mild steel, and subjected to the same heat-treatment. In one figure are given the I, H curves for ring and bars, and in a second the demagnetising factor N is graphed with I. As noted by Benedicks and Shuddemagen [see Abs. 503 (1902), and 1916 (1907)], N is approximately constant only for a certain range of values of I. Below I = 200, N appreciably diminishes with I, and above I = 800, it diminishes as I increases, first slowly and then more rapidly, passes through a minimum and increases very rapidly to a high maximum, diminishing suddenly to zero when I is at saturation value. It follows that when a magnetic field is produced between two masses of iron which are saturated, it is unnecessary to use an armature to close the circuit, since the demagnetising field is not active. G. E. A.

390. *Currents Induced in a Conductor by the Passage of a Magnetic Mass over it.* **E. S. Bieler.** (Roy. Soc., Proc. 100. pp. 50–60, Oct. 4, 1921.)—A theoretical investigation gives an expression for the e.m.f. induced in an infinitely long, straight conductor by the motion of an iron shell, of given radii and permeability, over it at a given distance and speed. The deflection which this e.m.f. would produce in a critically-damped moving-coil galvanometer is also investigated, and the theoretical results are tested by experiment. The magnetic mass was a 16-lb. sphere of iron, and it was moved over a rectangular coil of 200 turns and 125 cm. side, the coil being connected to a galvanometer whose deflections were registered photographically. Experiments were carried out for three positions of the coil, and graphs are given which show a single wave of e.m.f., and the corresponding galvanometer deflection for each case. It is concluded that theory agrees with experimental evidence, and that the deflection is proportional to the voltage sensitivity of the galvanometer, the earth's field, the amount and distribution of the magnetic material in the shell, and inversely proportional to the depth of the conductor below the level of the shell, and the period of the galvanometer. The deflection lags behind the e.m.f.; this is ascribed to the inertia of the moving system. G. E. A.

391. *Magneto-Chemistry of the Chromic Chlorides.* **J. B. Elias.** (Anal. Fis. Quim. 16. pp. 467–483, May, 1918.)—The chromic chlorides are green or violet in aqueous solutions. The magnetic susceptibility is studied by the method of Quincke, or by the solenoid method (concentrated solutions) under different conditions of concentration, temperature, and acidity. In either salt the susceptibility is additive (Wiedemann's law). When the green is converted into the violet modification, or vice versa the magnetic constant does not change; measurements were made at intervals of up to 886 hours; the magnetic constant hence does not appear to change when other properties change. In this respect Cr differs from Co, and it is suggested that the linking between the Cr atoms and other atoms is effected through the more external electrons. The author finds 19 magnetons in the Cr atom like Cabrera and Marquina, but his susceptibilities differ from those of Feytis [Abs. 1205 (1913)]. H. B.

392. *Effect of Field Strength on Molecular Magnetism of Paramagnetic Salt Solutions.* **G. Falckenberg.** (Zeits. f. Physik, 5. 4. pp. 201–207, 1921.)—In previous work, the same solutions have not been tested in both strong and weak fields. The author does this by means of isoparamagnetic solutions. To prepare these, the solution was placed in a glass trough in a field of 3·1 kilogauss. A small bulb containing a $FeCl_3$ solution of known concentration was suspended, by a cocoon thread, in the solution. By adding drops of concentrated solution or of distilled water, until the bulb was neither attracted nor repelled by the field, the paramagnetism of the two salts could be equalised, the effect of adding a drop of water to 13 cm.^{3} of solution causing an observable displacement of the bulb. The solutions thus obtained were tested for isoparamagnetism in fields under 10 gauss produced by an alternating current of frequency 1000, Heydweiller's method being employed. Fields of less than 1 gauss at frequency 94,000 were also used. It is concluded that the molecular magnetism of solutions of $FeCl_3$, $FeSO_4$, $Mn(NO_3)_2$, and $MnSO_4$ is independent of the field strength. [See also Abs. 2730 (1904).] G. E. A.

393. *Theory of the Electromagnetic Field in Ferromagnetic Metals.* **W. Arkadiev.** (Ann. d. Physik, 65. 7. pp. 643–656, Sept. 27, 1921.)—In the first part a sketch is given of the author's theory which was published in 1913, and the results of the measurements, based on this theory, are repeated [see Abs. 558 (1914)]. It is now pointed out that in Gans's work [Abs. 312 (1921)], the final formulæ agree with those of the author. Also it is pointed out that certain information is given in his original paper which has been overlooked, and that on other points Gans has misquoted or misunderstood the author. G. E. A.

394. *Some Galvanometric Effects.* **A. Sellerio.** (N. Cimento, 22. pp. 119–150, Sept.–Oct., 1921.)—Mathematical and experimental continuation and development of the author's previous work [Abs. 937 (1921)] on the true Hall-effect, the transverse Hall-effect, and perturbation in these. A. D.

CHEMICAL PHYSICS.

395. *Protoactinium (Ekatantalum). I. Separation from Pitchblende.* **O. Hahn** and **L[ise] Meitner.** (Deutsch. Chem. Gesell., Ber. 52. pp. 1812–1828B, Oct. 15, 1919.)—In the preparation of radio-active substances from pitchblende protoactinium, for which the symbol Pa is proposed, is found in the insoluble residue, essentially of silica, after extraction with nitric acid. The pitchblende may first be fused with sodium-hydrogen sulphate, the residue being treated with HF, or the mineral may at once be treated with HF and H_2SO_4, or be extracted with nitric acid. Details of the three methods are given. It is always advisable to add a little tantalum oxide (0·5 or 1 per cent.) to the residue. The protoactinium is a higher homologue of tantalum, and should in the periodic table lie between thorium and uranium, where Fajans and Goehring (in 1913) placed brevium (life, 1·15 minutes). Assuming the ordinal number 91, Pa should have the atomic weight 230; a substance to the left of thorium in the table should have the atomic weight 232·2, so that this atomic weight sequence would show the same irregularity as in the cases of potassium-argon and tellurium-iodine. The Rutherford-Boltwood ratio of 8 per cent. for the actinium-branch series should probably be reduced to 3 per cent. For the life period of Pa the present limits are 1200 and 180,000 years. Examination of more old uranium preparations is desirable. H. B.

396. *Intramolecular Change of Place of Similar Atoms Studied by Radio-Activity.* **G. v. Hevesy** and **L. Zechmeister.** (Deutsch. Chem. Gesell., Ber. 53. pp. 410–415B, March 13, 1920.)—When activated lead nitrate (radio-active) and inactive lead chloride are dissolved in molar proportions in hot pyridium, and the boiling liquid is then allowed to cool, the chloride crystallising out is found to be exactly half as radioactive as the nitrate was. The same is observed with the formate and acetate in water, and with plumbous and plumbic acetate in glacial acetic acid, the exchange of place between the lead atoms being in agreement with the law of probability, but only when the lead salts can form lead ions. When the Pb is bound with carbon to a non-dissociating compound, as in lead tetraphenyl dissolved in amyl alcohol, intramolecular interchange does not take place. H. B.

397. *Absorption of Hydrogen by Rhodium.* **A. Gútbler** and **O. Maisch.** (Deutsch. Chem. Gesell., Ber. 52. pp. 2275–2280B, Dec. 13, 1919.)—By reducing the hexachloride of rhodium and ammonium, Wilm had obtained a bright grey rhodium, which absorbed hydrogen very energetically, whilst the pentachloride yielded a much less active metal. These observations were not confirmed by Quenessen. The authors reduce the sodium-rhodium chloride by hydrazine in faintly acid, neutral, and ammoniacal solutions, and obtain in the three cases a deep black, a grey-black, and a grey metal, which in the purest condition still contained 3 per cent. of water and 0·3 of oxygen. The three modifications absorbed hydrogen in the order stated, the deep black most, 206 vols. at 0°. The absorptive capacity of Rh for hydrogen is much smaller than that of palladium, and resembles that of platinum; spongy rhodium, like spongy platinum, absorbs little hydrogen. H. B.

398. *Chemical Effects of Penetrating Radium Radiations.* XII. *The Equilibrium of Fumaric-Maleic Acids. Action of the Radiations and of Ultra-Violet Light on Aqueous Solutions of Uren, Benzoic Acid, and Formic Acid.* **A. Kailan.** (Akad. Wiss. Wien. Ber. 129. 2A. No. 6. pp. 527–537, 1920. Comm. from the Inst. f. Radiumforschung.)—Exposure to Ra radiations [Abs. 1341 (1920)] raises the electrolytic conductivity of aqueous solutions of fumaric acid and diminishes that of maleic acid, whilst the titres of both the solutions decreased; the latter effect was not due to any alkalinity of the glass. Similar experiments made with mixtures of the two acids, exposed for up to 3000 hours to the rays passing through 1 mm. of glass, gave similar results; acrylic acid seems to be produced. Blank tests showed no changes. Aqueous solutions of uren did not change their refractive index nor their density when exposed to Ra; the electrolytic conductivity was slightly increased, but also in blank tests. Aqueous formic acid exposed to the rays of a quartz mercury-lamp did not change their conductivity; oxalic acid was not formed, whilst exposed aqueous solutions of toluene gave some oxalic acid, direct or *via* benzoic acid. The conductivity of oxalic acid is not affected by Ra, but that of benzoic acid is increased; the density and the refractive index of the benzoic acid were not affected, but the decomposition increased more rapidly than the concentration, which was not so in the case of formic acid. Whilst further, in the case of formic acid, the mercury rays were 270 times more rapid in their action than the Ra radiations, the ratio was 7 : 1 in the case of benzoic acid. Ordinary distilled water did not change its conductivity on exposure to the Ra radiations for 2300 hours. H. B.

399. *Surface Colours of Metals.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr. pp. 225–236, May 16, 1919. Chem. Zentrbl. i. p. 148, 1920.)—The rate of the thickening of tarnished oxidic surface films can be estimated from the alteration in the colours. Some metals yield similar films with iodine vapour, and these are more convenient for study. The isothermal rate of film formation on silver depends solely on the coefficient of diffusion of the iodine into the AgI layer. The phenomena are somewhat as in Nernst's theory of solution; whilst, however, in solution the deposit is detached and the thickness of the layer is constant, the thickness of the film, through which the attack is made, is increasing. The chemical action itself is far more rapid than the diffusion, and the quantitative relation therefore depends upon the properties of the reaction product. When crystals of iodine are placed over sulphuric acid in a desiccator, films and surface colours form on Ag, Cu, Pb, Tl; Bi and Sb darken with a fine dust; Sn gives a yellow incoherent layer; on Fe, Ni, Co, Mn small patches of hygroscopic droplets form within a few minutes; Zn and Cd are slowly and more regularly attacked; Cr is doubtful. To keep the iodine concentration constant in quantitative experiments, air is drawn through iodine solution. Silver behaves differently when rolled and cleaned, when melted and hence covered with large crystallites, and when unworked and covered with many small crystals. Copper behaves similarly, but the refractive index of copper iodide is not known, and the thickness of a corresponding film of air can hence not be calculated. In many temperature regions the rate of increase of the superficial layer is independent of the temperature; this is true for steel, for which the author bases his calculations on the experiments of Löwenherz. H. B.

400. *Reading Graphic Tables. Volume Correction for Moist Gases.* **M. Hofsäss.** (Zeits. angew. Chem. 32. pp. 319–320, Oct. 7, 1919.)—A kind of slide rule (turning cylinder) for reducing the volumes of mosit gases to dry gas at normal pressure and temperature. **Wa. Ostwald** (*ibid.*, 32. pp. 359–360, Nov. 11, 1919.)—A diagram on logarithmic scale for effecting the same correction by graphic calculation, a modification of the device of Hofsäss. The latter replies. H. B.

401. *Photochemical Studies.* V. *Triboluminescence.* **J. Plotnikow.** (Prometheus, 30. pp. 235–236, April 26, 1919. Chem. Zentrbl, iii. pp. 462–463, 1919.)—To excite triboluminescence under constant conditions the substance is placed between the top of a cylinder of marble (or agate) and a plate of glass (or quartz for harder materials), the cylinder being rotated. An illuminated band is then seen, which is photographed by a special camera, also described. For demonstration the use of salophen is recommended; it gives a pale-green luminiscence. H. B.

402. *Sorption of Hydrogen by Amorphous Palladium.* **J. B. Firth.** (Chem. Soc., J. 119. pp. 1120–1126, July, 1921.)—It has been previously shown [Abs. 775 (1920)] that the sorption of hydrogen by palladium foil is essentially "adsorption" below 0° and that "absorption" diminishes with lowering of temperature below 0°, whereas adsorption increases. The object of the experiments now described was to determine the sorption capacity of palladium black at temperatures ranging from 100° to about − 190° (liquid-air temperature) by two distinct methods: (1) The Pd was heated at 100° and the hydrogen then admitted, the metal being left in contact with the gas at 100° for 20 mins. and then cooled slowly in hydrogen to the required temperature and an equilibrium established at atmospheric pressure. (2) The Pd was cooled to the required temperature in a vacuum and hydrogen then slowly admitted until an equilibrium was established at atmospheric pressure.

The results obtained show that the sorptive capacity of palladium black varies according to the method of preparation employed. This absorbent contains both amorphous and crystalline Pd, the proportions of the two varying with the conditions of the preparation; when the palladium black is heated, the proportion of the crystalline variety increases. The sorptive capacity of palladium black at low temperatures depends on the temperature at which the sorption begins. Palladium black saturated with hydrogen at 100° sorbs further quantities of the gas when gradually cooled in it. The sorptive capacity decreases slightly as the temperature falls from 100° to 20° and increases continuously as the temperature falls from 20° to − 190°. T. H. P.

403. *Confirmation of Einstein's Photochemical Equivalent Law.* **W. Noddack.** (Zeits. Elektrochem. 27. pp. 359–364, Aug. 1, 1921.)—Two reactions are studied, (I) action of bromine vapour on hexahydrobenzene (cyclohexane, C_6H_{12}), and (II) of liquid chlorine on trichlorobromomethane, $CBrCl_3$. The experimental arrangement is substantially the same in both cases. A nitra lamp of 1500 candles is placed within a water trough; the condensed rays pass through filters of green (solution fo ferrous ammonium sulphate) and blue (malachite green) into a trough in front of which the spectrophotometer and a Rubens thermopile are mounted; in the first series of experiments the two observations (absorption and energy) were determined in the direction of the longitudinal axis of the cylindrical trough, in the second series (with $CBrCl_3$) in different directions. In (I) there is a slow complicated reaction in the dark, in (II) there is not at ordinary temperature [see next Abs]. In both cases Einstein's law is applicable. When in (II) carbon tetrachloride is added as a diluent, the photochemical effect diminishes as the dilution increases, owing to the energy loss by collisions between a photochemically activated chlorine molecule and an acceptor molecule of $CBrCl_3$, with which it reacts; the life period of this activation is estimated at 10^{-9} sec. When the activated molecule does not find an acceptor molecule during this period, it radiates its energy or it loses it by indifferent collision with the diluent, which is heated. H. B.

404. *Colloid Synthesis by Means of Pulsating Arcs.* **G. Börjeson** and **T. Svedberg.** (Kolloid Zeits. 25. pp. 154–158, Oct., 1919.)—The arcs are produced between vertical electrodes immersed in the alcohol of a beaker, with capacity and inductance in the circuit; the potential is 440 volts, the current less than 0·5 amp., the gap small. The anode is more disintegrated than with the kathode, and the whole disintegration much more rapid and powerful than with the arcs described by Svedberg in Abs. 743 (1914). The authors speak of the new arrangement, which gives intermittent discharges, as Wellenstromlichtbogen, but they apply the same term also to the previous arrangement, which was a damped oscillatory discharge. The colloidal solutions so prepared of Sb, Pb, Bi, Zn, Ag, Cu, Al, Cd are fairly stable, though a certain amount of the metal always settles; gold and platinum do not give stable colloids. In the case of Sb this process is 5 times as rapid as with the old Svedberg method. H. B.

405. *Preparation of Disperse Solid Substances in Gaseous Media* (*Air*). **V. Kohlschütter** and **J. L. Tüscher.** (Zeits. Elektrochem. 27. pp. 225–256, June 1, 1921.)—Crystallisations and condensations generally start from a few separate spots, and disperse products are first formed which may be momentary or persistent. In spite of the varied optical and electric studies of gaseous reactions and the technical importance of catalytic processes and of the smoke problem, the nature of the fume and smoke particles forming in indifferent gaseous media has received little attention. The authors describe in this first article the preparation of metallic fumes in air and the nature of the oxidic deposits produced by the electric discharge passing through them. Metals are burnt (Mg) or directly volatilised (As, Sb) by heat, or volatilised in the arc between a block of carbon, holding about 4 gm. of the metal in a cavity, and a pointed electrode, within a Borchers furnace. The fumes pass into a spacious chamber provided with baffles to make the mixture of air (drawn through the furnace and apparatus at a velocity of about 0·7 m. per sec.) and fume homogeneous and to retain coarse particles, and then down a vertical cylinder of iron, into which a detachable aluminium cylinder fits closely;

a steel wire is axially stretched in the cylinder as the one electrode of the earthed cylinder. As a rule the boiling of the metal is more smooth when the block is kathode than when anode. A deposit is apt to form on the wire especially when the wire is anode; generally the wire is, therefore, made the kathode. This peculiarity is reversed, however, when water-vapour is admitted into the chamber; then dense plugs of loose and apparently dry oxide settle on the wire kathode whilst a moist paste is deposited on the cylinder, on which the deposit is meant to be received. The metals of the iron group boil under sparking and spitting. Most of the metals used were pure; calcium and silicon were also tried as carbides. All the deposits were highly disperse. Aluminium gave a smooth snowy-white deposit of oxide, which appeared brownish in transmitted light under the microscope; larger particles disintegrated in the presence of water and liquefied into turbid masses in the presence of traces of ammonia or of hydrochloric acid. Similar peptisations were observed in other cases. H. B.

406. *Reactions between Ferrous Oxide and Carbon and between Carbon Monoxide and Iron.* IV. **V. Falcke.** (Zeits. Elektrochem. 27. pp. 268–278, June 1, 1921.)—The author reviews his own previous work (since 1913) and that of Schenck and Zimmermann (since 1905) and others, being unable to continue the research. The experiments are made on a small scale in porcelain tubes with powdered iron (also nickel). The equilibrium constant of the reaction: $C + CO_2 \rightleftarrows 2CO$ is found not to be the same below 700°, as that resulting from the reaction between ferrous oxide and graphite and between CO and Fe. From this and analytical data it follows (contrary to Schenck) that elementary carbon plays no part as one of the decisive phases. The earlier assumption that the equilibrium depends largely upon the carbides formed seems the most probable. The author had formerly ascribed importance to the amorphous or graphitic condition of the carbon; the recent X-ray work makes this improbable. It would also appear that the generation of pure hydrogen (free of hydrocarbons) from an iron is no sure evidence of the absence of carbon, as he had believed. H. B.

407. *Separation of Mercury into Isotopes.* **W. D. Harkins** and **R. S. Milliken.** (Nature, 108. p. 146, Sept. 29, 1921.)—The paper refers to experiments made by the authors to separate the isotopes of mercury. The evidence that an actual separation has been obtained rests largely on the quantitative agreement between the results of Brönsted and v. Hevesy and of the authors.

Evidence has also been obtained that a slight separation of the isotopes of mercury has been secured by a very slow distillation at very low pressures, though a more rapid distillation gave no detectable difference in density. A. B. W.

408. *Atomic Structure of Metals in Solid Solution.* **A. L. Feild.** (Chem. Met. Eng. 21. pp. 566–570, 1919.)—Experimental data on specific resistance, general considerations as to hardness, and the electronic theory, all furnish indications that solid solutions contain a large amount of super-cooled metal having a liquid or amorphous structure. L. H. W.

409. *Interpenetration of Solids; Penetration of Copper by Zinc and Tin.* **H. Weiss** and **P. Lafitte.** (Comptes Rendus, 173. pp. 146–148, July 18, 1921.)—In continuation of the work on the interpenetration of metals previously described [Abs. 160 (1921)], experiments have now been made to ascertain if the phenomenon of penetration into the solid metal exhibits discontinuity at the instant when the other metal melts, if the phenomenon persists at lower temperatures, and if the phenomenon extends to other metals than the zinc-copper pair.

Experiments made at 420° show that no discontinuity exists for the penetration of zinc, tin, or mercury into copper. Further, at 100° copper is quite appreciably penetrated by zinc or tin in the course of a month. Experiments have also been made at temperatures slightly below the lower melting-point with copper in conjunction with Sn, Al, Sb, Ag, Au, and Ni, these binary systems representing melting-point diagrams of all types. Interpenetration occurs in all cases except with copper-aluminium, with which contact between the two metals is probably prevented by a thin film of alumina, since the phenomenon is not observed even above the melting-point of Al. T. H. P.

410. *Influence of Manganese on Malleable Cast Iron.* **E. Leuenberger.** (Stahl. u. Eisen, 41. pp. 285–287, March 3, 1921. Rev. de Mét. 18 E. pp. 419–420, Dec., 1921.)—While some metallurgists would not admit more than 0·4 per cent. of manganese in cast iron, higher percentages actually occur without any detriment. So far the influence of manganese on the segregation of graphite had chiefly been studied. The author fuses Swedish iron with ferromanganese to obtain specimens containing from 0·13 up to 1·74 per cent. of Mn in addition to about 2·8 C, 0·4 Si, 0·076 P, and 0·04 S. The 12 charges were heated for 95, 130, or 260 hours. The tensile strength increases as the Mn increases; the elongation is not influenced up to 1 % Mn, to decrease with higher Mn; prolonged heating lowers the tensile strength and raises the elongation (this in contradiction to Wüst); the longer the heating the higher may be the Mn percentage. Thus 0·4 per cent. of manganese may well be exceeded, but manganese favours the formation of blow-holes and renders the casting of thin-walled specimens more difficult. H. B.

411. *The Baumann Sulphur Test for Iron. Phosphorus in Iron.* **P. Oberhoffer** and **A. Knipping.** (Stahl u. Eisen, 41. pp. 253–258, Feb. 24, 1921. Rev. de Mét. 18 E. pp. 617–619, Dec., 1921.)—In the Baumann test of 1906 sulphuric acid is poured on the iron, and the blackening of silver-bromide paper by the vapours is observed. Heyer objected that in the presence of phosphorus there would also be blackening by phosphorus hydrides. The author prepared 16 melts of electrolytic iron in a vacuum furnace, mixing the samples with sulphide or phosphide of iron; the specimens contained either S (up to 0·14 %) or P (up to 1·1 %) or both. Especially when hydrochloric acid is used instead of sulphuric acid there may be some reaction with the phosphorus. But when the test is performed under usual conditions (sulphuric acid of 1·12 density at 25° C. for not more than 15 minutes) the Baumann test is reliable, and the blackening by phosphides is faint in any case. Further tests confirm A. Fry (Dissertation, Breslau, 1920) that phosphorus readily diffuses through iron, but not in the presence of carbon. In pure phosphorus iron homogeneity can be produced by heating for a short time to 1300° or for longer periods to 1200°. In carbon steels and alloy steels segregation of phosphides may disappear after heating to

1200° for 50 hours, but such thermal treatment is technically not always successful. H. B.

412. *Strain Figures in Etched Steel.* **A. Fry.** (Stahl. u. Eisen, 41. pp. 1193–1197, Aug. 11, 1921. Engineering, 112. pp. 809–811, Dec. 16, 1921.)—By combining intense etching with a special heat-treatment of cold-worked mild steel the author obtains very peculiar " strain figures," which generally appear as two systems of parallel dark lines crossing approximately at right angles. The reagent used is a strong solution of copper chloride in water and alcohol, containing so much acid that copper is not deposited upon the iron ; the deposit is said to consist of copper hydride and to react with the iron under formation of iron hydride. The etching lasts a few minutes, and may have to be repeated by rubbing the surface with powdered copper chloride ; the surface is gently dried then and washed with alcohol. When the etching is continued for hours the lines deepen, but some of the detail is lost. The lines are considered to represent surfaces of discontinuity and of gliding analogous to the angle of repose. When sheet metal is punched by a round tool, heated to 760° and then etched, a white zone of maximum deformation surrounds the hole and from this zone curious dark curves extend outward intersecting at the constant gliding angle. When the specimen is first drilled and then bent, peculiar bending stress patterns develop on etching. These figures do not, in general, mark the maximum deformation, but, rather, moderate deformation. When, however, the number 97 was stamped into cold steel and the surface ground down, the 97 reappeared in white—not dark—on etching. So far the strain figures have only been observed in mild steel after applying stress, but not in all mild steels. Etching alone after cold work is not sufficient to bring out the figures ; reheating has to follow. Discussing the microstructures (photographs reproduced) the author regards the figures not as direct primary effects of plastic or elastic deformation, but as secondary phenomena which the thermal treatment develops as a consequence of the strains left in the metal. The strain figures can be made to vanish again by continued heating into the temperature range of solid solutions. Heating up to 600° sometimes made the figures indistinct ; in other cases heating to 760° was required to bring the phenomenon out well. The strain figures are not understood yet, and cannot directly be utilised, hence, as tests of the quality of the material. But both the figures and " blue brittleness " are observed when the specimen has been stressed near 200° or been heated to that temperature after cold work. H. B.

413. *Critical Heat-Treatment of Cold-worked Mild Steel.* **A. Pomp.** (Stahl u. Eisen, 40. pp. 1261–1269, Sept. 23 ; 1366–1378, Oct. 14, and pp. 1403–1415, Oct. 21, 1920. Rev. de Mét. 18E. pp. 574–587, Nov., 1921.)—The thermal treatment for cold-worked steel may yield a coarse or a fine grain. Reviewing the recent literature, the author concludes that the coarse-grain structure is favoured by a carbon percentage not exceeding 0·18 (Sherry), deformation below A_3 (Sauveur, C. Chappell), and a heat range of 650 to 850°. His own experiments were made in the Felten-Guillaume Carlswerk with half a ton of mild steel (Krupp) containing 0·05 % C, 0·1 Mn, 0·005 P, 0·035 S, 0·024 Cu, and traces of Si, the total impurities not exceeding 0·214 per cent. ; segregations were not discernible. The bars were heated to 1125° C. and rolled down

in 13 operations from 63 mm. square to 30 × 15 mm., the temperature not sinking below 920° during the rolling. The reheated bars were then rolled down to rods of from 14·5 to 10 mm. diameter, while the furnace cooled to 900, 800, 700, 600°, and this was repeated at 500, 400, 300, 200, 100, and 10° C. Each test rod was cut in halves and tested directly or after thermal treatment in pots used for wire annealing. The tests comprised Brinell hardness, tensile tests, breaking strength, yield point, elongation, contraction (on an Amsler machine), impact tests (Charpy), and microscopic examination. On the whole former observations are confirmed. Most of the curves of the changes consequent upon treatment (mechanical and thermal) were fairly regular; the contraction of area showed hardly any regularity. The chief conclusions of practical interest are the following:—A mild steel to be rolled warm, at red heat, should not be allowed to cool below A_3 (900°) while on the rolls. If the temperature should sink below that, (*a*) reheating from 650 to 850° will tend to produce a coarse grain when the diminution in cross-section lies within the range 5 to 20 %, and that may occur also when reheating is not applied; (*b*) at higher reduction in cross-section the steel will behave as if hardened. When the metal is shaped in the cold, reheating from 650 to 850° will be advisable provided the reduction in area exceed 16 %; within the critical range of contraction 8 to 16 % the steel would turn crystalline and sensitive to shock, and the reheating temperature should then exceed 900°. Sometimes a change in the properties will be desired; it was so, *e.g.*, with the special mild steel used which was made during the war to replace the copper bands of shells; the making and fixing of these bands and their testing are described in detail. When finally a mild steel of high strength, of great hardness and a certain diminution in cross-section is required, the material should be worked, not in the cold, but at 200°. With a diminution in area of 2 % rolling at 200° would raise the breaking strength 20 % and the hardness 15 %; the impact strength would, however, be lowered, and the procedure is not generally advisable. H. B.

414. *Effect of Quenching a Brass Containing Aluminium.* **A. Portevin** and **J. Philippon.** (Rev. de Met. 18. pp. 533–534, Aug., 1921.)—A discussion on the microstructure of a brass containing 71 % of copper and about 4·5 % of aluminium. As cast the metal is homogeneous, but on annealing it becomes duplex. Annealing and quenching at about 850° C. gives rise to a martensitic structure. J. L. H.

415. *The Ternary System Aluminium-Copper-Zinc, especially the Zinc Corner.* **V. Jares.** (Internat. Zeits. Metallogr. 10. pp. 1–44, Jan., 1919. Chem. Zentrbl. iii. pp. 512–514, 1919.)—After reviewing the literature on the binary alloys, the author discusses the system Al-Zn-CuAl-$CuZn_4$, which he resolves into four equilibrium triangles, to each of which a ternary, non-variant, pseudo-eutectic point belongs, lying outside the triangle apparently. The compounds entering are Al_2Zn_3 (the decomposition of which at 256° is not further investigated), CuAl, $CuAl_2$, and $CuZn_4$. Ternary compounds were not observed. For these researches the alloys were prepared by fusing the pure metals in an electric furnace in an unglazed porcelain crucible with alloys containing 20, 50, or 70 % Cu. For the study of the mechanical properties commercial zinc (with about 1 % Pb) was taken. In slowly-cooled Zn-Al the hardness increases with increasing Al first rapidly, up to 10 % Al, then remains constant, and increases very slowly above 20 % Al. In the system Zn-Cu the hardness has a maximum at 5 % Cu, and a minimum at 12 to 14 %; this minimum is also observed in slowly-cooled ternary Al-Cu-Zn, but not in quenched specimens. The tenacity of Zn-Cu alloys has a maximum at about 10 % Cu, whilst that of Zn-Al alloys increases on addition of copper up to about 10 % Cu, then to fall. The fracture of Zn becomes finer on the addition of Al without alteration of the structure. The tenacity and hardness of brass and ordinary bronze are readily attainable in Al-Cu-Zn, but the latter alloys are brittle. Technically 10 % Cu is the maximum, 4 % Cu the minimum advisable in these Al-Cu-Zn alloys. The Al percentage should not exceed 5, and should be lower if Cu be present. The alloys are not recommendable to the engineer on account of their low strength, and because they are easily oxidised by steam, alkalies, natural waters, and many salts. They are suitable for instrument-making and fine mechanical work. H. B.

416. *Alloys of Copper-Aluminium-Zinc Rich in Zinc.* **E. H. Schulz** and **M. Waehlert.** (Metall. u. Erz. 16. 8. pp. 170–176, and 9. pp. 195–201, 1919.)—The authors study the alloys Zn-Cu, Zn-Al, and Cu-Al-Zn, containing up to 10 % Al. The zinc contained 0·26 % Pb. The metals, zinc first, are fused under charcoal in porcelain crucibles; the total loss of metal never exceeded 0·3 per cent. Full equilibrium diagrams, also three-dimensional, and photographs of the microstructure are reproduced; the diagrams are complex. Zinc dissolves 0·75 % Al at 380°, and at room temperature. The addition of 1·9 % Cu does not affect the Zn-Al diagram when the alloy is rich in Zn; on further addition a ternary alloy with 1·5 Al and 2 Cu, melting at 350°, appears. Both Cu and Al make Zn harder; in the case of Al, the maximum hardness is attained by 5 % Al, so that an alloy with 9 % Cu and no Al is as hard (Brinell test) as one containing 3·5 % Al and 4 % Cu. The same metals increase the tenacity of Zn. Zinc itself is always liable to plastic deformation, and has no proper elastic limit; 10 % Cu raise the elastic limit to 30 kg./mm.^{2}. There is no relation between tensile strength and the equilibrium diagram; the hardness and crushing strength increase strongly within the range of the mixed crystals. Boring tests (depth of the hole produced by 100 rotations of the drill) after Kessner (dissertation, Berlin, 1915) were also made. H. B.

417. *Alloys of Manganese with Bismuth, Zinc, and Silver.* **P. Siebe.** (Zeits. anorg. Chem. 108. pp. 161–183, Oct. 1, 1919.)—A study of manganese alloys had been commenced in the same institute, at Göttingen, by R. S. Williams, but had not been finished; Mn-Zn had not been investigated so far, Mn-Hg by Hendrichs in 1908 and by Arrivaut [Abs. 1536 (1913)], both in the same journal. The manganese used is prepared by the thermit process; specimens of 20 gm. are fused in a hydrogen atmosphere in Haldenwanger tubes. Mn and Bi are not completely miscible; with more than 23 % Mn this metal collects in the upper layer, over an alloy with 23 % Mn. In this cooling curves show 5 arrests, corresponding to 5 crystalline phases, with horizontals at 442°, 597°, 1093°, and 1252°; the last eutectic contains 0·5 % Bi, which lowers the melting-point of Mn by 13 deg. The hardness increases with the Mn; the alloys are ferromagnetic, the magnetic constituent is probably the first compound crystallising out. In Mn-Zn the Mn percentage does not exceed 50; the alloys are brittle, and become harder with more Mn. In the Mn-Ag alloys, those with 0·22 and 0·24 mol. of Mn differ chemically from those containing 0·26 and 0·28 mol.; the latter are attacked by silver sulphate (depositing silver), by copper sulphate (depositing Cu), and by HCl and H_2SO_4 (generating H). The electric potentials show similar distinctions; it is not quite certain, however, that the alloy with more than 0·26 mol. Mn has the potential of pure Mn, because in the solutions the surface changes by losing Mn. H. B.

418. *Growth Phenomena in Copper, Silver, Gold.* **A. Beutell.** (Centrbl. Mineral. pp. 14–28, Jan. 1 and 15, 1919.)—Having observed (*ibid.*, p. 471, 1916) that, when sulphur vapour acted on silver, the solid silver travelled through the sulphide formed, the author made further experiments, heating either silver foil alone, or some artificial Ag_2S, or this sulphide and some silver foil in glass tubes, about 1 cm. wide, which were highly evacuated. Silver foil alone heated for 8 days to 450°, and then to 585°, did not develop any excrescences of warty or hairy silver; at 450° Ag and S do not interact at low pressure. The Ag_2S remained unchanged at 450° for 4 days, and then began to show a few threads of hair silver, which did not develop on further heating. But when the sulphide and silver foil were heated together, growth of hair silver and of dendritic crystals was observed after 1 day at 450°; while the silver foil developed a hole, from which Ag had penetrated into the sulphide. The silver migrated from the hot to the cold portions, and the migration was reversed by turning the tubes upside down. Natural silver sulphide behaved like the artificial product. Similar results were obtained with Cu_2S and Cu, but the growth was much slower. Selenium and tellurium also gave similar results; gold travelled very slowly through silver selenide; in silver telluride threads of hair, 5 in. long, were obtained in 10 days. Mossy copper and gold were also observed. The growth is more rapid when the heating takes place in air, because the decomposition of the sulphide is hastened. H. B.

419. *Colloidal Mercury by Kathodic Disintegration.* **A. Gútbier** and **G. L. Weise.** (Kolloid Zeits. 25. pp. 97–100, Sept., 1919.)—A layer of 0·5 cm. of mercury is placed in a trough and covered with water or some other liquid. Into the mercury dip the anode (Pb wire) sheathed with glass and the kathode, also a platinum wire; the arc is struck by pulling the kathode out of the mercury into the water. Currents of 3 or 4 amps. at 110 or 220 volts are recommended. Clouds of colloidal mercury, bluish-grey and grey, are formed; they are not very stable, and coagulate in 24 hours; by addition of gum arabic to the water the solutions may be stabilised for 14 days, but the method is only intended for demonstration. H. B.

420. *Mechanism of Various Preparations of Mercury Hydrosols.* **I. Nordlund.** (Kolloid Zeits. 26. pp. 121–138, March, 1920.)—An account by S. Odén of the work of the late author, done mostly under Svedberg, on the various methods of preparing Hg hydrosols: I mechanical, II thermal, and III electrical dispersion are studied. I. When mercury jets are injected or dropped at high velocity into water, pure or containing traces of glycerin, or some ammonia or ammonium salt, very little hydrosol is obtained. Shaking water with mercury in the presence of alkali salts was also inefficient; ammonium salts (chloride, sulphate) proved a little more efficient; potassium citrate gave a stable hydrosol; carbamide (non-electrolyte) was inefficient, a very small amount of gelatin (0·015 %) acted as a protective colloid. II. Passing a stream of superheated mercury vapour into vapour was unsuccessful. III. Electric dispersion by direct arcs, and especially by high-tension alternating-current arcs, proved most efficient; the mercury drops, *e.g.*, from a glass tube (anode) into a mercury pool (kathode). Curves are reproduced in the paper showing the distribution of mercury particles of various sizes in the more stable colloids. H. B.

421. *Automatic Sedimentation Recorder and its Uses in Colloid Chemistry.* **S. Odén.** (Kolloid Zeits. 26. pp. 100–121, March, 1920.)—Illustrated descriptions of an apparatus for studying and automatically recording the rate of sedimentation of colloids and for investigating the mode and time of aggregation, the mean and true diameters of particles, the reversibility of the processes, the influences of concentration and of electrolytes, etc. A disc of gilt brass is suspended in a fall cylinder, 38 cm. diam., 35 cm. high, so as to form a false bottom, less wide than the cylinder. The disc is suspended from one arm of a balance, and sinks when loaded to a certain weight; as it sinks, an electric relay causes a pellet to be thrown on the other scale pan, so that the fall disc is raised again; these movements are electrically recorded. An experiment may take 100 hours, H. B.

422. *Differentiation between Molecular and Colloidal Solutions. Segregation in Cast Iron.* **W. Ostwald.** (Kolloid Zeits. 26. pp. 138–140, March, 1920.)—According to W. Ostwald colloidal solutions do not show the freezing-point depression of molecular solutions. When a molecular solution freezes there is a progressive change in the ice lumps deposited, and the final mother-liquor is not the original liquid. This is noted in colloidal solutions, though there may be some horizontal stratification. Osann and Wolf [Grundriss der Eisenhüttenkunde, i. p. 528 (1915)] applied this to the study of segregation in cast iron. Adding sulphur to 12 kg. of fused iron and cooling slowly they found that the carbon and sulphur settled in horizontal layers, as if colloidal, partly at least, whilst manganese and phosphorus settled in zones about a central core, suggesting molecular solution. H. B.

423. *Electrolytic Migration. Electrolysis of Mixed Solution of Alkali Salts.* **M. H. van Laer.** (Rec. Trav. Chim. Pays Bas, 39. pp. 301–329, April 15, 1920.)—The object of the research is to arrive at high caustic alkali concentration at the kathode when the cell is fed with diluted alkali. When sodium hydroxide is electrolysed at 18°, the current yield (the transport number of OH′ being 0·825) is only 17·5 % of Faraday's law, and this is further varied by hydrostatic pressure, diffusion, electro-osmosis, temperature, nature of diaphragm, etc. In diaphragm cells Griesheim obtains a caustic concentration of 2·5 per cent., the bell-process (Aussig) 8 per cent., Billiter 200 to 250 gm. per litre. A better yield might be expected from the electrolysis of sodium carbonate, just as Haeussermann obtains dichromate and alkali by electrolysis of chromate; but $NaHCO_3$ is formed by absorption of the CO_2, and the resistance increases. This formation of acid carbonate is prevented by the addition of oxy-salts, alkali sulphate, chlorate, or (best) nitrate. This successful method can also be applied to barium carbonate, which in the presence of $BaNO_3$ in the anode compartment, yields crystalline barium hydroxide. The experiments are made in troughs containing a porous pot with the kathode. H. B.

424. *Reduction of Barium Nitrate by Alternating Currents.* **P. Wenger** and **A. Lubomirski.** (Annal. Chim. Analyt. [ii.] 1. pp. 339–342, Nov. 15, 1919.)—The apparatus used has already been described (*ibid.*, 1914). The various metallic electrodes do not reduce the aqueous solution of barium nitrate when the circuit is broken. Currents of 0·2 to 7·5 amps. at 25 to 35° give nitrite; the experiments lasted up to 8 hours. Mercury electrodes give the best yield, at 0·6 amp.; the other electrodes tried are Ni, Cu, Sn, Pb, Zn, Mg, Cd, Al. Higher temperature increases the yield at Pb, decreases it at Al or Zn electrodes; otherwise temperature has little effect. The oxygen liberated forms suboxides (Cu, Hg, Cd, Sn), or hydroxides (Pb, Zn, Al, Mg), or oxides (Ni, Ag); the nitrite formation depends upon the oxidisability of the electrode, and upon its surface development, the seat of the reactions being that surface. H. B.

425. *Electrochemical Reactions of Nitrogen and the Accompanying Spectroscopic Phenomena.* **L. Hamburger.** (Chem. Weekblad, 15. pp. 931–942, July 27, 1918.)—When a mixture of 3H + N is passed at a pressure of 12 mm. of Hg through a capillary quartz tube, and exposed to a discharge of 12 amps. per sq. cm., the yield of ammonia is 109 mgm. per kw.-hr. The yield is increased by conditions favouring the activation of the two gases, and diminishes with increasing time of exposure and decreasing current density. The spectroscope shows that in these cases, as in mixtures of N with O and CO, molecules are broken up and compounds like CN are formed; photographs of the spectra are reproduced. H. B.

426. *Electric Osmosis of Fused Sodium Chloride in Carbon Electrodes.* **W. Ostwald.** (Kolloid Zeits. 25. pp. 115–116, Sept. 19, 1919.)—When fused sodium chloride is electrolysed with carbon electrodes very little chlorine is liberated; the positive carbon does not appear to suffer, but the negative begins to glow from the tip upward, and swells and disintegrates. Cooled, the negative carbon does not conduct the current; it is brittle and crumbles when washed with water; the carbon particles are not colloidal. The destruction is not due to metallic sodium, but to fused chloride, which rises in the carbon as in a wick. H. B.

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